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GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE AND AGRICULTURE.

Memorandum on the snowfall in the mountain districts bordering Northern India and the abnormal features of the weather in India during the past year, with a forecast of the probable character of the south-west monsoon rains of 1899.

The present memorandum is drawn up in accordance with the practice of the past fifteen years, and includes, firstly, a brief summary of the information received from various officers relating to the snowfall of the past winter or cold weather in the Afghan mountains and the Himalayan area; secondly, a statement of the chief peculiarities or abnormal features of the meteorology of India during the past year; and, thirdly, a forecast of the probable character of the approaching south-west monsoon rains based on this information.

The forecast is based in part on the snowfall information and on the abnormal features of the weather during the past five months, and in part on a comparison with the meteorology of the previous twenty-two years, so far as it is available. It is necessary to point out that the forecast is a statement of probabilities and not of certainties, and that it is liable to error from the limitation and uncertainty of part of the data on which it is based. It has been drawn up after a consideration of all the available information, but it should, to use the words of the Famine Commission Report, "*be used with due caution.*"

The monsoon forecasts, as at present issued, necessarily leave out of consideration two important points on which the agricultural value of the monsoon rainfall largely depends, *viz.*:

(1) the probability of the occurrence of a prolonged break in the rains in July or August;

(2) the probability of the unusually early termination of the rains in North-Western and Central India or in Bengal;

and are hence imperfect every year to that extent.

The chief features or conditions which influence and determine the extension and general strength of the south-west monsoon currents are as follows:

1st.—The amount and time of occurrence of the cold weather snowfall in the mountain districts adjacent to Northern India.

2nd.—The local peculiarities of the weather in India immediately antecedent to the advance of the monsoon currents across the coasts of Bombay and Bengal into the interior, and which, it is found, are generally initiated during the hot weather, and are frequently more or less persistent in character. These abnormal features are, on the whole, best estimated by means of the variations of pressure from the normal.

3rd.—Local peculiarities in the Bay of Bengal and Arabian Sea, over which the monsoon currents pass before they reach India, and probably also the Indian Ocean, which is the source of the massive current of the south-west monsoon in India.

The first of these conditions or factors is mainly influential in determining the northern limits of the monsoon rains, heavy and prolonged snowfall in the Western Himalayan area either preventing or delaying the extension of the monsoon current over Upper India during the rainy season. Heavy and untimely snowfall in April and May especially exercises a very powerful influence in this way.

The second factor determines those large local district or provincial variations of rainfall during the monsoon, which are evidently due to persistent local

conditions or peculiarities, and not to general causes influencing the whole of India more or less.

The third and last factor is at least of equal importance with the preceding two, but it is that on which information is most difficult to obtain and is least in amount and longest in being received. In fact, information respecting the weather conditions in the Arabian Sea, Bay of Bengal or the Indian Ocean has hitherto been rarely received in time to be utilized in drawing up the annual forecasts. Special arrangements have been made to obtain telegraphic information from Zanzibar, Mauritius and the Seychelles in the hope that it might throw some light upon the conditions at present prevailing in the south-east trades region in the Indian Ocean.

REPORTS OF SNOWFALL ON THE AFGHAN MOUNTAINS AND HIMALAYAS DURING THE WINTER OF 1898-1899.

The whole of the information referring to the snowfall in the mountain districts bordering Northern India for each month of the year is now published as it is received in the India Monthly Weather Reviews.

The following gives a brief summary of the information relating to the snowfall of the past cold weather obtained up to date.

I.—AFGHAN MOUNTAIN DISTRICTS.

HILLS WEST OF DERA ISMAIL KHAN, INCLUDING WAZIRISTAN.

(1) WANA.

The following is a summary of the reports received from the Political Officer, Waziristan:

November.—No snow was reported.

December.—Light snow fell on the night of the 20th—21st on the highest peaks and heavy snow on the 24th, and during the period, 27th to the 29th, down to about 8,000 feet. Snow was lying to the depth of 3 to 6 inches on the peaks above 8,000 feet high at the end of the month.

January.—Light falls of snow occurred on the highest peaks on the 12th and 30th.

February.—Snow fell on the 3rd, 5th, 8th, 9th, 10th, 13th and 23rd of this month on the Marwattai hills above 7,500 feet. There was a slight accumulation of snow on the north faces of the hills at the end of the month.

March.—Snow fell on the 11th, 12th, 13th, 26th and 27th on the Marwattai hills. The falls were generally light and melted rapidly.

April.—No snow fell on the Marwattai hills. The snowfall of the past winter was much lighter than usual throughout the whole winter.

(2) DERA ISMAIL KHAN (KULACHI BORDER).

The following is a summary of the reports received through the Deputy Commissioner, Dera Ismail Khan District:

December.—Snow fell on the higher peaks of the Suleiman Range from the 28th to the 30th. The total fall varied in depth from 1½ feet to 3 feet on the higher peaks. It soon melted.

January.—Fine weather prevailed throughout the month until the 30th when a snowstorm gave 5 feet of snow to the higher peaks of the Suleiman Range.

February —Frequent storms occurred during the month, and snow fell on the 2nd, 3rd, 4th, 8th, 9th, 10th, 14th and 15th on the Suleiman Range. The

total fall on the higher peaks is stated to have been 30 feet in depth. (This estimate is probably much exaggerated.)

The Deputy Commissioner states that "during the year 1898-99 the depth of the snowfall on the Suleiman Range amounted to 41 feet as against 23 feet in 1897-98."

(3) KURRAM.

The following is a summary of the reports received from the Superintendent of the Meteorological Observatory, Parachinar, and the Political Officer, Kurram Valley:

September.—Snow fell on the highest peaks of the Sufed Koh on the 15th, 17th and 28th.

November.—Light snow fell on the highest peaks on the 15th, 17th and 25th.

December.—Snow fell on eleven days during the month. The falls descended to heights varying from 16,000 feet at the beginning of the month to 8,000 feet at the end of the month. During the last storm of the month (on the 28th), which was very heavy, snow fell down as low as Kohat (elevation 1,767 feet).

January.—The month was much finer than usual. Snowstorms occurred on the 12th, 13th, 29th and 30th, but the falls were very light.

February.—Snow fell on the 4th and 5th and again from the 7th to the 10th and also from the 12th to the 14th and the 22nd to the 24th. 2½ feet of snow were reported to be lying on the Peiwar Kotal at the end of the month.

March.—There were snowstorms on the 2nd, 3rd, 9th, 11th, 12th, 15th, 16th and the 27th to the 29th. The last storm of the month occurred on the highest peaks of the Sufed Koh above 14,000 feet. About 6 inches of snow were lying on the Peiwar Kotal at the end of the month.

April.—Snow fell on six days in April, *viz.*, the 4th and the 14th to the 18th on peaks above 16,000 feet in elevation. There was practically no snow lying on the Sufed Koh on the 15th of May. The snowfall of the past winter was less than that of the preceding winter and below the normal.

(4) THAL SUB-DIVISION (KOHAT DISTRICT).

The Assistant Commissioner, Thal, writes that "during the past winter there has been no snowfall in any part of the sub-division, except the Samana Range, where the fall is estimated at 3 feet."

(5) KABUL.

The following is a summary of the information received from the Meteorological Observer, Kabul, through the British Agent:

December.—Snow fell on the 18th, 25th and 28th, but the falls were light. The Paghman and adjoining hills were covered with snow at the end of the month.

January.—A storm gave light falls of snow on the 29th and 30th.

February.—Snow fell on the 2nd, 8th, 9th, 10th, 13th, 14th and 23rd. The falls at Kabul were light, and the total of the month was only 14 inches. The storm of the 13th and 14th was severe and extended as far south as Ghazni, closing the passes for a fortnight. There was no snow accumulation in the valley at the end of the month. The Paghman hills were covered with snow throughout the month.

March.—Light snow fell on the 3rd, 9th and 15th. The Paghman mountains were covered with snow at the end of the month, but no information had been received of the depth of the accumulation. The snowfall of the past winter is considered by the inhabitants of Kabul to be considerably below the normal.

(6) KHYBER PASS DISTRICT.

The following is a summary of a report of the snowfall in this area during the months of January and February forwarded by the Political Officer:

"During the winter the snowfall, compared with former years, has been very slight indeed. At Lundi Kotal, *i.e.*, on the Loargi Plain (3,600 feet elevation), the snow in January melted as it fell, and there was no accumulation. The snowfall on Tor Sappar (5,260 feet) and what is shown on district maps as the Tartara Peak (6,775 feet) must have averaged on each occasion between 6 and 8 inches. There were three falls during the winter—one late in January and two in February. The snowfall in Maidan has also been scanty compared with former years.

"The inhabitants generally state that, compared with former years, they have had no snowfall at all this year."

(7) CHITRAL.

The following gives comparative data of the precipitation at the recently established observatories of Chitral and Drosh for the period November to April:

Chitral.

Year.	Rainfall.						
	November 1898.	December 1898.	January 1899.	February 1899.	March 1899.	April 1899.	Total fall, November 1898 to April 1899.
	Inch.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
1896-97	0	0·02	4·88	2·94	4·65	4·20	16·69
1897-98	0	1·68	0·63	1·65	15·25	6·28	25·49
1898-99	0·05	1·55	0·10	2·28	3·11	2·10	9·14

Killa Drosh.

1897-98	0	1·98	1·45	1·26	12·12	5·34	22·15
1898-99	0	1·16	0	2·19	2·27	2·66	8·28

The data establish conclusively that the precipitation of the past winter was much less in amount at these stations than during the previous two winters, and suggest that the snowfall in that mountain district was very considerably below the normal and probably barely 50 per cent. of the normal fall.

The following report has been received from the officer in medical charge, Killa Drosh:—"The post of Drosh is about 4,500 feet high. Snowfall generally occurs in the territories of Drosh during the months of October, November, December, January, February, March and April and is of frequent occurrence on the higher mountain ranges and of occasional occurrence over the valley. There is one mountain to the east of Killa Drosh about 16,000 feet high. It is covered with snow during the whole year. To the west of Killa Drosh is a lower mountain range about 11,000 feet high. The Lawarai Pass, which is about 18 miles to the south of Drosh, is 10,000 feet high. Snow lies there more or less nearly throughout the whole year except the months of August and September. There were 21 falls of snow during the year on the following dates:—23rd October, 13th November, 12th, 16th, 17th and 24th December, 2nd and 14th of January,

14th and 23rd February, 2nd, 4th, 12th, 15th, 16th, 26th and 27th of March and the 10th, 11th, 16th and 17th of April. The falls from the 14th January to the 26th March extended to Drosh and the neighbouring hills. The remaining falls were received on the higher ranges only. The area over which these storms are known to have extended is about 50 miles to the north, east and west and about 30 miles to the south of Drosh.

"The total snowfall during the past winter at Drosh was 4 feet and 11 inches in amount. The depth of snow over the peaks of the highest mountains is not at present known, but is probably about 10 feet on the mountains situated to the east of Killa Drosh. The Lawarai Pass is covered with a considerable amount of snow at present; the depth of snow is estimated from 3 to 10 feet.

"The inhabitants of the country state that the snowfall during the past winter was less than in the corresponding period of the previous year."

II.—HIMALAYAS.

(A) THE PUNJAB AND KASHMIR HIMALAYAS.

(1) HAZARA.

The following report has been received from the Deputy Commissioner, Hazara District:

"The first fall of snow on the highest peaks occurred in October. It was, however, light and soon melted. The first heavy fall occurred on the 29th December down to 4,500 feet. The depth of the fall at a height of 10,000 feet was probably one foot. Light snow fell again down to 6,000 feet on the 6th and 7th January and more or less heavy snow on the 3rd, 5th, 6th, 7th, 10th, 11th, 14th and 15th February. The total fall at a height of 10,000 feet measured about 6 feet in depth. Snow fell down to 7,000 feet on the 6th, 9th, 12th, 13th, 14th and 16th March and on the higher mountains down to 8,000 feet on the 12th, 16th, 17th, 18th and 19th April. The total fall in April was from 1 to 3 feet.

"The storms extended over the whole of the ranges in this district and between the storms the weather was generally fine.

"There was about 2 feet of snow on the Babusar Pass on the 5th of May and some snow as far down as Narau in the Kagan Valley and on the hills over 10,000 feet high.

"The total fall of the winter was somewhat less than usual."

(2) MURREE.

The following tables give statements of the snowfall as measured at Murree and on the hills near Kahuta during the past and preceding winters for comparison:

Station.	Total fall of snow in the month of					Total of period, 1898-99.
	December 1898.	January 1899.	February 1899.	March 1899.	April 1899.	
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Murree . .	0 11	0 3	6 4	*Nil*	*Nil*	7 6
Kahuta . .	...	*Nil*	7 0	*Nil*	*Nil*	7 0

Station.	Total fall of snow from January to March in											Average of eleven years.
	1899.	1898.	1897.	1896.	1895.	1894.	1893.	1892.	1891.	1890.	1889.	
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Murree .	7 6	6 8½	10 2½	7 5	11 10	15 9	29 4	0 5	29 0	3 8	7 3	11 9
Kahuta .	7 0	13 2	4 0	1 0	6 0	5 0	18 0	*Nil*	5 8	0 9	4 3	5 10

The data show that the snowfall at Murree was considerably below the normal and was comparable in amount with the falls in the cold weathers of 1898, 1896 and 1889. The fall at Kahuta was, on the other hand, slightly above the average of the past eleven years.

(3) KASHMIR.

The following account of the snowfall in Kashmir during the early part of the winter was received from the Meteorological Reporter to the Kashmir State in February last:

"The Kashmiris say that a severe winter in the valley is usually followed by a mild one and *vice versâ*. Last year's winter was unusually dry, and it was therefore anticipated that during this winter heavy snow would fall, and this anticipation is now a realisation. The snowfall in and around the Kashmir Himalayas during this winter has been heavy, though not more than the average.

"Snow began to fall earlier than usual this winter, and a great deal fell in December and in February, whilst in January very little fell.

"In January the weather was generally colder but finer than usual. At the end of the month it was thought that the winter was over, but it suddenly changed on the 2nd February when a snowstorm occurred lasting 8 hours. Another snowstorm, more severe than the first, occurred on the 4th February and lasted for twenty-four hours, bringing down 2 feet of snow. Two other storms occurred on the 9th and 13th February, but were of moderate intensity.

"On the mountains surrounding the valley the snow lies very deep. On the Banihal Pass (9,200 feet) there are, it is said, 15 feet of snow and at Gulmarg 7 feet.

"Most of the snow melted as it fell in the valley in February. This, however, is not the case with snow falling on the hills surrounding the valley."

The following table shows the snowfall measured as rain during this winter and previous five winters for comparison:

Year.	Precipitation.						
	December.	January.	February.	March.	April.	May.	Total of period.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
1898-99 . .	2·73	0·68	4·21	2·01	3·44	1·38	14·45
1897-98 . .	0·35	1·91	2·15	0·76	1·28	2·64	9·09
1896-97 . .	0·63	6·18	1·38	5·79	4·93	4·53	23·44
1895-96 . .	0·62	1·09	2·46	2·22	1·48	2·22	10·09
1894-95 . .	1·91	6·11	4·81	5·30	2·63	1·55	22·31
1893-94 . .	0·26	7·16	4·25	4·47	4·09	1·52	21·75

The comparison indicates clearly that the precipitation at Srinagar during the past winter was much less than during the winters of 1893-94, 1894-95 and

1896-97 and also so far as can be judged from the limited data below the normal by at least 20 per cent.

The following additional memorandum, dated the 23rd May, on the character of the snowfall in Kashmir during the past winter has been received from Dr. Mitra, Meteorological Reporter, Kashmir State:

"During the last winter 7·62 feet of snow fell in the valley, a detailed report of which was sent to the Meteorological office on the 20th February. No more snow has fallen in the valley since the submission of that report. On the 24th February, while it rained in the valley, heavy snow fell on the surrounding mountains. On that date over a quarter of a foot of snow was measured at Dras. Nearly 4 feet of snow fell at Dras in the month of March and over 3 feet in April, and on the 4th May a snowstorm occurred there bringing down 1½ feet of snow. On the 11th March and 17th April snow fell heavily on the hills in Kashmir descending as low down as the Takht-i-Suleiman (6,000 feet). There is at present 3 feet of snow on some parts of the Banihal Range. At Gulmarg there was 1 foot of snow so late as 5th May. Over the Zoji-la Pass (11,300 feet) there is about 5 feet of snow, and on the Rajdangan Pass (11,800 feet) there are, it is said, 12 feet. All the mountains around the valley are covered with deep snow. The spring in the valley was unusually wet and cold and prolonged. From all accounts it appears that the snowfall on the higher ranges has been more than usual, and that it is lying on the higher as well as on the lower passes longer than usual. In the valley it is now colder than usual, and unsettled weather is the chief feature we notice this year. The river Jhelum is at present higher than usual. As it is still cold in the valley, the snow does not melt, and while it is raining in Srinagar, it is showing on all the hills. Light showers of rain at intervals in June and July will melt the snow slowly on the mountains, but if there should occur a heavy rainfall by the middle of June, it is apprehended that a severe flood will occur.

"From the 18th May we have had hazy weather. On the 19th a heavy storm of wind occurred which dispelled the mist for a time, but it again came up after the storm was over."

(4) LEH.

Very full accounts of the snowfall during the past winter in Ladakh have been received from the Superintendent of the Leh Observatory. The following is a brief summary of these reports:

October.—Snow fell on the 23rd on the hills surrounding Leh down to an elevation of 12,500 feet. It also fell during the following night in the Indus Valley near Leh. It melted rapidly during the remainder of the month, and the snow-line was at a height of about 15,000 feet at the end of the month.

November.—No snow fell.

December.—Light showers of snow fell on the 8th, 10th and 13th. On the 16th there was no snow on the Karzong Pass (elevation 17,500 feet). Heavy snow fell over the whole Indus Valley in Ladakh from the 16th to the 18th. Light falls were received on the 19th, 21st and 22nd, and a second heavy general fall occurred from the 29th to the 31st.

January.—Light snow showers fell in Leh and the neighbourhood on the 1st, 13th, 17th, 25th and 31st. The falls on the mountain ranges to the south of Leh were apparently heavy.

February.—Snowstorms occurred on the 3rd, 9th, 10th, 18th, 19th and 24th. These storms were all general extending over the whole Upper Indus Valley and side valleys. Heavy snow fell over the neighbouring ranges down to 12,000 feet on the 15th.

March.—There was a severe snowstorm on the 6th and again from the 9th to the 12th. The fall melted rapidly in the valley which was free from snow again on the 15th.

April.—Snowstorms occurred on the 9th, 10th and 19th over the whole of Ladakh. There were also snowstorms on the higher ranges above 13,000 feet on

the 18th, 19th, 21st, 22nd, 24th and 25th. The depth of snow on the Karzong Pass at the end of April was about 4 feet.

May.—During the period from the 1st to the 15th some rain showers fell in Leh. The snow-line never descended lower than 15,000 feet. The accumulation on the Karzong Pass on the 15th of the month was from 3 to 4 feet

The inhabitants of Leh consider that the snowfall of the past winter was similar in total amount to that of the winter of 1896-97 and considerably greater than that of the winter of 1897-98.

(5) LAHOUL.

The following gives a statement of the snowfall registered at the Observatory at Kailang in Lahoul during the past winter and also during the corresponding periods of the past five years for comparison :

Month.	Normal monthly precipitation measured as rainfall.	RAINFALL, 1898-99.	SNOWFALL, 1897-98.	SNOWFALL, 1896-97.	SNOWFALL, 1895-96.	SNOWFALL, 1894-95.	SNOWFALL, 1893-94.
		Total precipitation of month measured as rainfall.	Total snowfall of month.	Total snowfall of month.	Total snowfall of month.	Total snowfall of month.	Total snowfall of month.
		Inches.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
December	1·01	3·57	0 6½	1 9	*Nil*	4 0	0 3
January	3·07	0·42	0 6½	5 8	1 2	3 6	3 6
February	3·20	3·17	2 5½	1 2	3 1	2 0	4 3
March	3·39	3·13	0 3	6 10	0 10	3 6	5 4
April	2·80	4·26	*Nil*	?	*Nil*	1 6	2 1
Total	13·47	14·55	3 9½	15 5	5 1	14 6	15 5

The precipitation at Kailang during the period, December to April, was hence slightly above the normal (8 per cent.). It was equivalent to about 12 or 13 feet of snow, and hence was similar in amount to that of the corresponding periods in 1896-97, 1893-94 and 1894-95.

The Superintendent of the Observatory describes the winter as follows :

" We enjoyed very fine weather from October up to the beginning of December, but the weather broke up rather suddenly, and in the second-half of December we had very heavy snowfalls which entirely blocked up the Rotang Pass. January was bright and fine, the sky being almost always blue. February and March brought us a good amount of snow again, and so did April. Taking everything into consideration, we had a favourable winter. Since the 25th of April we have had no snowfall whatever, but from the 10th to the 14th of May it rained pretty heavily, and on the night from the 13th to the 14th May we had a regular thunderstorm. This occurs very seldom at this height. "

(6) SIMLA HILL DISTRICTS.

The following is a summary of the data for these districts received from the Deputy Conservator of Forests, Bushahr Division :

September.—Snow fell on the 26th down to 10,000 feet and again on the 29th.

October.—Light snow fell above 10,000 feet on the 14th.

November.—Snow fell down to 6,500 feet on the 5th. The depth of snow on the Kanawar Range at 8,000 feet was about one foot at the end of the month, and the passes across these ranges were closed.

December.—Slight snow fell on the 12th, 13th, 16th and 17th above 7,000 feet. Moderate snow fell on the 20th and light snow on the 21st, 24th, 25th and 26th above 5,750 feet. There was a heavy fall on the 30th and 31st over the whole district down to 5,750 feet. All passes over 10,000 feet were closed throughout the month.

January.—Heavy snowfalls were received over the whole area above 5,750 feet on the 2nd, 3rd and 4th. Fine dry weather prevailed during the remainder of the month.

February.—Heavy falls of snow occurred on the 5th and 6th and again on the 26th above 5,750 feet. Slight falls were also received on the 4th, 9th, 13th, 14th, 15th and 24th above 9,000 feet. The weather was unusually cold in the Sutlej Valley after the storm of the 13th to the 15th.

March.—There were light falls on the 7th, 9th, 10th, 11th, 12th and 13th above 10,000 feet. All the passes over 12,000 feet in elevation were closed throughout the month.

April.—Light to moderate falls of snow occurred on the 1st, 6th, 8th, 9th, 10th, 12th, 13th, 14th and 15th above 9,000 feet and again from the 16th to the 23rd above 10,000 feet.

These snowstorms were accompanied by much thunder and lightning and were general over the whole of Bushahr. All the passes higher than 12,000 feet were closed up to the 15th of the month. The depth of snow at 10,000 feet on open slopes of the northern aspects of the ranges was 18 inches on that date.

May.—Light snow fell down to about 10,000 feet on the 12th and 15th and some sleet on the higher ranges from the 16th to the 18th. During the period from the 16th April to 18th May storms were of almost daily occurrence in Bushahr west of Kilba, and gave more or less snow on slopes above 10 000 feet. From the beginning of May the snow on the southern aspect of the hills melted rapidly, and the snow-line retired to 12,000 feet. In the intervals between the storms the weather was fine and the sky free from cloud. The chief character of the storms was that they were almost daily brought up by south to south-east winds, and as far as observed extended over the whole of the Simla hill tracts west of Kilba.

On the 5th of May there was an accumulation of about 5 feet on the Rupin Pass, of about 6 feet on the Borenda Pass, of 8 feet on the Bulder Pass, of 6 feet on the Shatul Pass from the Pabor Valley to Nachar in the Sutlej Valley and 1 to 3 feet on the Harung Pass.

The snowfall of the season was, in the opinion of the natives of the district, considered to be about twice as much as in years of ordinary snowfall.

(7) CHAMBA.

The Deputy Conservator of Forests, Chamba State, has sent complete snowfall reports for the past winter, of which the following is an abstract:

December.—Snow fell on the 8th, the 12th, the 19th to the 21st and the 29th to the 31st. The snow-line descended to 7,000 feet on the 12th, to 6,000 feet on the 21st and to 3,000 feet during the last snowstorm of the month. The snowfall was reported to be very heavy on the interior ranges, more especially during the last storm of the month. There was 3 feet of snow on the Padri Pass between Chamba and Badrawar Pass on the 15th of the month.

January.—Snowstorms visited these hill districts on the 2nd, 3rd, 5th, 6th, 26th and 29th. The weather was unusually bright and clear during the month.

February.—Light snow fell on the 2nd and moderate to heavy snow from the 5th to the 7th, the 9th and 10th, the 15th and 16th and the 24th to the 26th.

The snowfall on the 15th and 16th occurred down to 5,000 feet and on the 24th to the 26th down to 7,000 feet.

The snowfall of the month occurred chiefly on the higher and interior ranges above 7,000 feet. On the 15th February there was a depth of 2 feet of snow lying at Kalatop (8,000 feet) and 7 feet at Barmaur (elevation 8,000 feet).

March.—Snowstorms occurred on the 6th and 7th and the 16th on the high ranges. The snowfall did not descend below 9,000 feet on the 16th, and it melted quickly again up to 11,000 feet.

April.—Light snow fell on the 9th, 12th and 13th. A general storm occurred on the 18th when snow fell as low as 6,500 feet in the main Ravi Valley. Thunderstorms were of frequent occurrence and were accompanied by snow on the higher ranges.

May.—Snow fell on the 13th down to about 10,000 feet, but soon melted, and the snow-line on the 15th was about 12,000 feet high.

The Deputy Conservator, writing on the 15th May, says:—"The depth of snow is not known on any of the high passes or ranges. The accumulation of snow down to 10,000 feet on the main ranges and in ravines appears to be rather more than normal, and of course is much greater than at the same time last year. This I attribute to cloudy weather in April and the frequent storms in May.

"The snowfall on the interior ranges is considered to have been somewhat greater than usual and similar in total amount to that of 1895-96. The winter began earlier than usual, but a peculiar feature was the long fine breaks between the storms in the middle of the winter. The total fall was probably below the normal on the lower ranges."

The following statement gives the snowfall as measured at certain forest stations during the past winter in the Chamba State:

Month.	Dalhousie neighbourhood.		West of State.	Tisa Range, north of State.					Valley of Ravi.			
	Kalatop, 8,000 feet.	Surkhigalli, 5,000 feet.	Bhandal, 6,000 feet.	Tisa, 5,000 feet.	Khangu, 7,000 feet.	Kundi.	Thanela, 7,000 feet.	Chanan, 6,500 feet.	Killar, 8,000 feet.	Chitrari, 6,000 feet.	Ulansa, 7,000 feet.	Barmaur, 8,000 feet.
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
December 1898	9 5	2 0	1 10	4 10	12 10	...	?	...	4 9	5 7	7 6	12 7
January 1899	2 0	0 7	1 7	2 3	5 2	...	?	...	0 2	1 7	2 10	3 7
February	No information.					...	?	...	5 6	3 1	9 11	17 0
March	"					...	0 9	...	3 2	0 3	1 0	5 1
April	"					...	...	...	2 3	...	0 2	6 4
May	...	...	...	...	...	...	...	...	...	...	...	...
Total	...	...	...	...	...	...	...	...	...	...	...	...
Total December to April 1897-98	13 10	1 0	3 5½	...	...	5 0	9 2	6 11	8 1	4 11	9 8½	8 1
" " " 1896-97	11 10	3 1	6 ½	...	...	?	15 3	9 2½	?	8 8	16 7	28 9
" " " 1895-96	8 0	?	3 10	...	...	?	8 11	3 10	16 6	?	?	?

(8) Dalhousie.

The Treasury Officer, Dalhousie, has sent the following report of the snowfall at that station and on the neighbouring hills:

"On the whole the fall of snow this year has been characterised by early commencement and early stoppage. Snow usually falls heavily or moderately in January and February, whereas this year the fall was confined chiefly to December. Out of a total fall of 5 feet, nearly 2 feet fell in the first week of January,

and there has been none since to record. The weather was mild and temperate in the months of January and February, which are usually the coldest months of the year. There is every sign of an early spring, and the prospects of crops around the station seem satisfactory.

"The total fall during past winter was about 5 feet in amount and hence approximately normal.

"No snow has fallen since the 8th January."

(9) KULU.

The following is a summary of reports received from the Assistant Commissioner, Kulu:

January.—Snow fell on the 2nd, 3rd, 5th, 6th and 30th in the Kulu Tahsil and on the 1st, the 3rd to the 7th and 30th in the Plach Tahsil. The falls of the 6th and 7th descended to 4,000 feet where the total amount was 4 inches.

February.—Snowstorms occurred on the 2nd, 5th, 6th, 14th, 15th, 24th and 25th in the Kulu Tahsil and on the 3rd, 5th, 6th, 7th, 11th, 15th, 16th, 24th and 25th in the Plach Tahsil. The falls on the 6th and 7th were unusually heavy and descended to an elevation of 3,000 feet where the total fall during the storm was 1 foot.

March.—Light snow fell on the higher ranges of Kulu on the 6th, 7th and from the 9th to the 18th. Some Lahoulis crossed the Rotang Pass in the middle of the month and nearly all passes in this district were open before the end of the month. The snow melted very rapidly during the last fortnight of the month.

April.—Snow fell on four days during the month on the higher ranges above 10,000 feet. The Rotang Pass was closed for three or four days, due to this snowfall.

May.—Rain fell slightly on the 1st, 11th, 12th and 13th in the Kulu Tahsil and on the 11th, 12th, 14th and 15th in the Plach Tahsil. During this period there was slight snowfall on the higher passes and peaks.

The Rotang Pass was not open for laden animals at the end of the month.

The snowfall of the past winter is generally considered to be heavier than usual.

The following table gives the depth of snow at the end of each month from January to May 1899 and also on the 25th May of the past eight years on seven of the passes in this district for comparison:

Tahsil.	Name of pass.	Elevation.	Depth of snow in					Depth of snow on the 25th May							
			January 1899.	February 1899.	March 1899.	April 1899.	May 1899.	1898.	1897.	1896.	1895.	1894.	1893.	1892.	1891.
		Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet	Feet.
Kulu	Hamta	14,500	9	10	8	3	½	½	6	1	3	6	7	½	12
	Rotang	13,000	11	12	11	7	5	3	7	8	6	9	9	1	9
	Bhubhu	10,000	4½	7	5	2	*Nil*	*Nil*	1	*Nil*	*N*	1	1	?	*Nil*
Plach	Gargarasan	17,000	8	9	6	3	2	1	4	2	2	2	4	1	4
	Srikand	15,000	13	14	9	6	5	5	8	7	10	12	15	4	32
	Basleo	11,000	6	6	3	1	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	1
	Jalori	10,500	6	6	3	1	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	1

The preceding statement showing the depth of snow on the higher passes on the 25th of May 1899 indicates that it was less than on the corresponding date in the years 1897, 1894, 1893 and 1891, and suggests that it was less than usual at the end of May. This is confirmed by the appearance of the snows on the higher Kulu ranges as seen from Simla.

(B) NORTH-WESTERN PROVINCES HIMALAYAS.

KUMAON.

The following is a statement of the estimated snowfall in this district measured in the same manner as in former years in accordance with arrangements made in the year 1890:

Month.	Fall on Pindari and Pankua Peaks.	Fall on Ralumdhura and Utamdhura Passes.	Fall on Malla Byans, Chandan and Darma.
	Ft. In.	Ft. In.	Ft. In.
16th September to 15th October 1898 . .	3 3	12 0	0 4
16th October to 15th November 1898 . .	2 4	9 0	1 4
16th November to 15th December 1898 . .	*Nil*	18 0	2 4
16th December 1898 to 15th January 1899 .	11 0	34 6	8 0
16th January to 15th February 1899 . .	No return received.		
16th February to 15th March 1899 . . .	0 9	13 0	5 0
16th March to 15th April 1899	1 6	18 0	*Nil*
Total fall in winter of 1899 . .	?	?	?
Total fall in winter of 1898 . .	18 8	66 6	0 6
Total fall in winter of 1897 . .	29 9	79 0	17 6
Total fall in winter of 1896 . .	14 0	32 0	9 6
Total fall in winter of 1895 . .	29 8	71 3	18 3
Total fall in winter of 1894 . .	33 3	57 3	33 6

The snowfall of the past winter in Kumaon was considered by the natives of the district to be greater than in the winter of 1897-98.

This is confirmed by the preceding data which also show that the fall was similar in amount to that of the winters of 1896-97 and 1894-95.

(C) ASSAM HIMALAYAS.

The following brief reports have been received through the Government of Assam:

Hills north of Lakhimpur.—The snowfall in the interior of the hills is reported to have been heavier than in the preceding winter.

Hills north of Sadiya.—The snow in these hills began to fall unusually early in the season and was very heavy. There was a very heavy fall late in March over the whole of the neighbouring Himalayas.

Hills north of Darrang District.—Almost all the hill people, who have come down this year, state that the snowfall of the past winter was heavy and the winter exceptionally severe.

Hills north of Kamrup.—Snowstorms occurred at frequent intervals during the winter, and the falls were unusually heavy in the months of November, December and the early part of January. The amount of snowfall during the year under report was greater than that of the preceding year.

(D) PERSIA.

The data for this area are very scanty. Weather was much finer and drier than usual throughout the whole season, but more especially in December, January and March, and the rainfall was scanty and in large defect over the whole Persian area. So far as can be judged from the imperfect data, it is almost certain that the snowfall on the higher elevations was as largely below the normal as the precipitation at the stations in the plains.

The following table gives comparative data of the precipitation at several stations in the Persian area and also at Quetta and Kashgar:

Station.	Rainfall.												Rainfall of period, November 1898 to April 1899.		
	November 1898.		*December 1898.*		*January 1899.*		*February 1899.*		*March 1899.*		*April 1899.*				
	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Percentage variation from normal.
Baghdad . .	0·70	—0·33	1·13	—0·82	0·26	—1·33	0·14	—2·35	0 55	—1·38	* 0·34	—0·85	3·12	—7·06	—69
Teheran . .	0·63	—0·41	0·57	—0·74	1·38	+0·22	0·96	—0·06	0·86	—2·17			4·40	—3·16	—42*
Ispahan . .	0·28	—0·8·	0 12	—0·33	0·20	+0·09	0·37	+0·33	0·65	—0·56			1·62	—1·35	—45*
Bushire . .	2·65	+0·49	1·90	—1·31	0·90	—2·49	2·01	—0·50	0·02	—0·85	0	—0·58	7·48	—5·74	—43
Jask . . .	0·16	—0·47	0 02	—0 41	0·10	—0 61	0·38	—0·95	0·73	—0 45	0	—0·06	1·39	—2·95	—68
Quetta . .	0·03	—0 24	0·41	—0·32	0 02	—2·09	2·01	—0·20	2·11	+0 41	0·10	—1·10	4·68	—3·54	—43
Meshed . .	0·90	+0·39	0·24	—0·14	0·05	—0·18	1·36	+0·46	2·38	+0·18	0·69	—1 24	5·62	—0·53	—9
Kashgar . .	0	—0·04	0	—0·27	0	—0·42	0	—0 13	0	—0·25	0	—0·12	0	—1·23	—100

* Rainfall of period, November 1898 to March 1899.

The data establish conclusively that the rainfall at the stations typical of the large area including Mesopotamia, Persia and Baluchistan was much smaller in amount than usual. The winter was unusually dry throughout, and the total precipitation of the period, November 1898 to April 1899, probably barely half the normal fall of the period. No special information has been received of the snowfall on the higher ranges in Persia. It is, however, almost certain that the scanty rainfall was due to special meteorological conditions common to the whole of the Persian area, hills and plains, and hence that the deficiency in the precipitation was as marked on the mountain ranges (which are the chief sources of the water-supply of the rivers and canals upon which cultivation so largely depends in Persia) as in the plains.

PRECIPITATION ON THE OUTER RANGES OF THE HIMALAYAS.

The distribution of the precipitation of the period on the outer ranges of the whole Himalayan area is indicated very clearly by the data of the following table:

Station.	Precipitation.												Precipitation of period, November 1898 to April 1899.		
	November 1898.		*December 1898.*		*January 1899.*		*February 1899.*		*March 1899.*		*April 1899.*				
	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Percentage variation from normal.
Cherat . .	0	—0·24	0·97	+0·25	0	—2·94	4·31	+1·97	2·43	—2·50	0·69	—1·61	8·40	—5·07	—38
Murree . .	0	—1·08	1·44	+0·24	0·16	—3·36	3·02	—0·71	2·66	—0·99	2·70	—0·70	9·98	—6·60	—40
Simla . . .	0·13	—0·41	3·09	+2·35	0·76	—1·50	2·23	—0·45	0·26	—1·98	1·14	—0·76	7·61	—2·84	—27
Kotgarh . .	0	—0·63	1·81	+1·20	0·45	—1·73	1·17	—1·59	0·57	—4·12	..	...	...	...	...
Kilba . . .	0·40	—1·57	4·09	+2·85	1·93	—3·68	3·94	—1·36	1 57	—4·43	...	...	...	...	...
Chakrata . .	0·24	—0·35	4·32	+3·66	2·34	—1·19	3·52	—0·29	1·13	—1·26	2·43	+0·95	13·98	+1·52	+12
Mussooree . .	2·25	+1·85	5·02	+3·96	2·11	—0·72	2·66	—0·23	0·65	—1·93	1·61	+0·19	14·30	+3·12	+28
Ranikhet . .	0·90	+0·57	2·51	+1·98	1·32	—1·62	1·97	+0·02	0·13	—2·11	1·82	+0·71	8·65	—0·45	— 5
Katmandu . .	0	—0·18	0·59	+0·34	1·34	+0·54	0·65	—0·43	1·22	—0·01	—2·02	—0·07	5·82	+0·19	+ 3
Darjeeling . .	0·75	+0·55	0·55	+0·33	0·41	—0·26	0·51	—0·43	2·79	+1·14	5·11	+0·50	10·12	+1·83	+22
Guntak . .	1·98	+0·55	1·44	+0·90	2·53	+1·84	4·08	+1·79	9 37	+4·32	8·27	—2·06	27·67	+7·34	—36
Yatung . .	0·02	—0·23	0·08	+0·03	2·06	+1·75	1·21	+0·83	1·51	—1·61	4·06	—0·90	8·94	—0·13	— 1

The precipitation of the period was in considerable to large defect at the hill stations on the outer and middle ranges of the Punjab Himalayas. The deficiency probably averaged about 40 per cent. and was larger, both in actual amount and relatively to the normal, at Kilba than at Simla. The precipitation was in moderate excess, on the average of the three stations, on the outer ranges of the North-Western Provinces Himalayas and in large excess in Sikkim. The distribution of the rainfall, as indicated by these stations, is in full accordance, it will be seen, with the snowfall reports.

SUMMARY OF THE SNOWFALL DATA.

The whole of the available data bearing on the character and amount of the snowfall in the mountain regions to the north and north-west of India have been given above. They have been given in fuller detail than usual, as the conclusions are opposed to statements that have appeared in various quarters with respect to the snowfall of the past winter. The data are very consistent and show clearly a gradual transition in the amount and character of the distribution from west to east. The winter snowfall and precipitation was very largely below the normal in Persia, Afghanistan, Chitral and Baluchistan, in slight defect in the Kashmir and Punjab Himalayas (due almost entirely to less precipitation than usual on the lower ranges combined with normal or slightly heavier fall on the interior ranges), in slight to moderate excess in Kumaon and Garhwal (or the Himalayas of the North-Western Provinces) and in large excess in the Eastern Himalayas of Sikkim and Assam.

The chief features of the snowfall of the cold weather were:

(1) The winter commenced somewhat earlier than usual in Afghanistan and Kashmir. Weather was unusually fine and free from winter storms in Afghanistan and Baluchistan from November to February.

(2) The number of cold-weather disturbances from November to January was considerably less than usual. Most of the storms in this period originated either in Baluchistan or India and not in Persia, and were hence of slight intensity. One storm, that of the 29th December to the 1st January, was severe and gave heavy and general snowfall in the Western Himalayas. The snowfall up to the end of February in that area was considerably below the normal on the whole and was nowhere excessive.

(3) The number of depressions in February, March and April was much larger than usual. Baluchistan, Afghanistan, Chitral and North Kashmir had frequent light to moderate precipitation during the period. A disturbance of moderate intensity extending from the 4th to the 6th February gave moderate to heavy snow in Kashmir and the Punjab Himalayas. The snowfall during this period was in slight to moderate excess in the Western Himalayas, chiefly due to the frequent falls in March and April, the excess being probably most marked on the interior and higher ranges.

(4) The chief feature of the season was the frequent moderate falls in April over the whole of the Western Himalayas west of Kumaon. The fall was moderately heavy in the Simla hill districts and Lahoul. Snow fell down occasionally to 9,000 to 10,000 feet and caused extensions of the snow-clad surface in the hills for brief periods which affected the meteorological conditions in Upper India. The snow melted very rapidly during the hot weather of the last fortnight of May, and the snow-line on the 31st of May was at a mean elevation of from 13,000 feet to 14,000 feet in the Punjab Himalayas and 15,000 feet in Ladakh.

(5) The snowfall of the past season up to the end of May was, so far as can be judged from the data, much below the normal in Persia and Baluchistan and in moderate to considerable defect

in Afghanistan as represented by Kabul, Wana, the Kurram Valley, the Khyber Pass and the neighbouring mountain ranges.

(6) The total fall of the period up to the end of May was probably about normal in amount or in slight excess on the higher and interior ranges of the Kashmir and Punjab Himalayas. This appears to be fully established by the information received from Kashmir, Chamba and the Simla hill districts. The precipitation of the period was, on the other hand, in considerable to large defect on the outer and middle ranges. There were only two periods of heavy snowfall in the Upper India Himalayas, *viz.*, from the 29th December to the 1st January and the 4th to the 6th February. During the early part of the season the intervals of fine, dry, clear weather between the storms were much more prolonged than usual. On the other hand, weather was more frequently disturbed in March and April than usual, and numerous light falls of snow were received on the interior ranges. So far as can be judged from the actual data received, the accumulation on the higher elevations in Kashmir, Lahoul, Chamba and the Simla hill districts was probably about normal in amount, and in Kulu and probably Ladakh was somewhat less than the normal. There is, hence, no abnormal extension of the snow-clad surface, the snow-line at the end of the period being at about 13,500 feet.

(7) The data for Garhwal and Kumaon (including those of the hill stations of Mussooree and Ranikhet) establish that the snowfall of the period was above the normal and probably to a moderate extent.

(8) No information has been received for Sikkim and Nepal.

(9) The information relative to the snowfall in the Assam Himalayas is as usual scanty, but appears to indicate that the fall was considerably heavier than usual over the whole of the Assam Himalayas.

The snowfall accumulation in May 1898 was unusually small, due to the abnormally dry weather of the preceding winter. Little or no snow fell during the south-west monsoon period from June to August 1898, and the accumulation on the higher ranges in the Western Himalayas at the end of August was probably less than at the corresponding period of the previous 10 or 15 years. A very early and heavy fall occurred in the fourth week of September which brought down the snow-line in Kashmir to about 8,000 feet. No further snow fell until the end of December. The falls were much less frequent than usual and with long intervals of bright clear weather in January and February. Frequent light snow was received in March, April and the first fortnight of May, chiefly on the higher ranges. The whole of the available data indicate that the extent of the snow-clad surface and the depth of the accumulation are abnormally small on the higher ranges in Afghanistan and Chitral, and that they are probably somewhat less than usual in the Kashmir and Punjab Himalayas. The height of the snow-line is also probably somewhat higher than usual in the Upper India Himalayas. The snowfall conditions in Upper India and the Persian area are hence favourable to an early and strong monsoon and to its extension to its utmost limits in the Punjab. The snowfall in the Eastern Himalayas has, on the other hand, been much heavier than the normal. It is, however, uncertain how far heavy snowfall in the Eastern Himalayas affects the strength and extension of the monsoon currents, as sufficient data of a trustworthy nature are not yet available for discussing this question for that area. Theory appears to indicate that it would tend, under the conditions of the present year, to diminish the rainfall in North-Eastern India and give increased rain to North-Western India.

ABNORMAL FEATURES OF THE METEOROLOGY OF INDIA DURING THE PREVIOUS EIGHTEEN MONTHS.

The meteorology of the dry monsoon (January to May) 1898 was very similar in several respects to that of the corresponding period of the present

year. The most important features of the meteorology of India during the first five months of 1898 were as follows:

(1) The snowfall of the winter of 1897-98 was much less than usual over the whole of the Western Himalayas and probably also in Afghanistan, Chitral and in Baluchistan. There was a heavy and somewhat abnormal fall in the second week of May over the whole of the Western Himalayas.

(2) The pressure conditions in India during the first five months of 1898 were such as accompany higher temperature in Northern India and less snowfall than usual in the Western Himalayas and probably also the Eastern Himalayas. The chief features, which were remarkably persistent, were (*a*) general deficiency of pressure, (*b*) local deficiency in Northern India and Burma, most marked in Bengal and Burma, and (*c*) local excess in Western India, greatest in Sind, Kathiawar and the Konkan.

(3) The temperature conditions during these five months were such as usually accompany a more open and drier winter than usual and scanty snowfall in the Himalayan area. Temperature was largely in excess in April and in moderate excess in May. The excess in these months was, on the whole, most pronounced in North-Western India and the North Deccan.

(4) The air was throughout nearly the whole season much drier than usual and skies remarkably free from cloud.

(5) The air movement was more vigorous than usual in March and April, due to the intensified thermal conditions of the period in the interior of India.

(6) Some of the abnormal features of the meteorology of India during the period were related to abnormal conditions prevailing in Persia and South Eastern Europe. Anti-cyclonic conditions obtained to a most unusual degree in Southern Europe in November, December and February, and, as a consequence, cool dry north-west winds prevailed in Persia with remarkable persistence from November to February. This abnormal air movement extended across Baluchistan and the north of the Arabian Sea and undoubtedly contributed to the unusual dryness of the air and freedom from severe cold-weather storms of the period in Northern and Central India.

It was stated in the south-west monsoon forecast published in the *Gazette of India* for 3rd June 1898 that the meteorological conditions in India immediately antecedent to the monsoon were, on the whole, favourable over the greater part of India; and hence that if, as was anticipated from information received form South Africa, Zanzibar and Mauritius, the conditions over the sea area to the south were favourable, normal or favourable rain might be expected over the greater part of the area. This anticipation was fortunately verified.

The general conclusions in the forecast were "that the rainfall may be deficient to a slight or moderate extent, depending chiefly upon the strength of the monsoon, in Sind, Cutch, the North and West Punjab and West Rajputana; that it will very probably be at least normal in amount in Central India and the northern half of the Peninsula, except perhaps Berar, Khandesh and the West Deccan, and may be in moderate excess in the eastern half of the North-Western Provinces, Bihar, the Central Provinces and the eastern states of Central India. It will probably be normal or in excess in Burma, Assam and perhaps in East and North Bengal, and may be in slight defect in West Bengal."

The south-west monsoon currents in 1898 were, on the whole, favourable as rain-distributing winds.

The south-west monsoon rains commenced somewhat later than usual on the Malabar and Konkan Coasts and almost simultaneously on the 9th and 10th

along the whole west coast. They began on the 16th, and hence about the normal date on the Bengal Coast.

The humid currents extended rapidly into the interior and gave general rain in Northern and Central India between the 11th and 18th. The first burst of monsoon winds in the Arabian Sea was very feeble, and the current fell off rapidly on the 17th and 18th. It withdrew temporarily from Upper India on the 19th, and the break in the rains gradually extended over practically the whole of India during the next four days. North and East Bengal received a heavy downpour on the 21st, 22nd and 23rd. The break was general from the 25th to the 28th on which day rain recommenced in North-Eastern India and extended over the greater part of the country by the end of the month.

The rainfall of the month was less than usual in Burma, Assam, Arakan, Berar, Khandesh and the greater part of Madras and was practically normal over the remainder of India.

The Bombay current was steady throughout July and was above its normal strength from the 13th to the 23rd and again from the 27th to the end of the month. The Bengal current was strong but somewhat unsteady, and three storms formed during the month in the north of the Bay of Bengal.

The first storm (lasting from the 2nd to the 8th) advanced from the head of the Bay along a west by north track to Lower Sind. The second lasting from the 16th to the 21st formed in Central Bihar and advanced almost due westwards to Sind. Both these storms gave moderate to heavy rain in the districts over which they passed. The third storm formed off the coast of North Madras on the 22nd and broke up in the North Deccan on the 26th. The rainfall of the month was above the normal over the greater part of India, including Chota Nagpur, South Bihar, the North-Western Provinces, Punjab, the Bombay Coast, the Deccan, the Central Provinces and North Madras. There was a moderate deficiency in Upper Burma, the Assam Valley, Central and North Bengal and Bihar. The rainfall of the month was hence abundant and favourably distributed.

The Bombay current was considerably weaker than usual in August, and the rainfall of the month was more or less below the normal over the whole area chiefly or entirely dependent on that branch of the monsoon current. The rainfall of the month in that area was, relatively to the normal, most deficient in the Punjab, Rajputana, Berar, the Bombay Deccan and Mysore. The Bay current was of normal strength, but was determined more largely to North-Eastern India than usual, and the rainfall of the month was in general excess in Burma (except perhaps Upper Burma), Assam, Bengal, the North-Western Provinces and the Central Provinces. The excess was, on the whole, most pronounced in Tenasserim (67 per cent.), Arakan (70 per cent.), the North-Western Provinces (58 per cent.), East Bengal (63 per cent.) and Assam (24 per cent.).

The Bombay current was slightly stronger than usual in September, but was, as in August, diverted from Upper India and determined more largely than usual to the Peninsula. The rainfall of the month was, hence, very deficient in North-Western India, almost as largely as in August. It was, on the other hand, in moderate to large excess over the centre and south of the Peninsula and in slight to moderate defect in the north of the Peninsula. The Bay current was of normal strength, but was, as in August, more largely directed to North-Eastern India than usual. The distribution of the rainfall was partly determined by the two cyclonic storms of the month which advanced along a more northerly track than usual from the Bay into Bihar and the North-Western Provinces. The rainfall of the month was excessive in Bihar and more or less above the normal in Bengal, Chota Nagpur and the eastern and central districts of the North-Western Provinces.

The Peninsula (chiefly the southern districts) received moderate rain during the first nine days of October. A storm formed in the Bay on the 9th and 10th which proceeded along a northerly track and gave very heavy rain in North Madras and Bengal from the 10th to the 15th. This was the conclusion of the

monsoon rains of 1898 in North-Eastern India. Fine dry weather prevailed over the whole of India until the 23rd when rain recommenced in Southern India and continued during the remainder of the month. A cyclonic storm formed in the south-west of the Bay on the 4th and 5th of November. It advanced westwards across the South Coromandel Coast on the 6th. Its advance gave moderate to heavy rain over the southern and central districts of the Peninsula from the 6th to the 14th. Dry weather set in on the 16th and continued until the 25th when showery weather recommenced. A disturbance formed in the extreme south-west of the Bay on the 28th and 29th. Its advance westwards was followed by heavy and general rain over Southern India from the 30th of November to the 2nd of December when dry weather was re-established.

The rainfall during the retreating south-west monsoon period was hence abundant and favourable over the greater part of the Madras Presidency and the Deccan, and the excess was large in the coast districts from Nellore southwards.

The following statement gives rainfall data of the south-west monsoon and retreating south-west monsoon periods in thirteen larger provinces:

Province or Division.	South-west monsoon period, June to October 1898.				Retreating south-west monsoon period, November and December 1898.			
	Average actual.	Average normal.	Variation from normal.	Percentage variation from normal.	Average actual.	Average normal.	Variation from normal.	Percentage variation from normal.
	Inches.	Inches.	Inches.		Inches.	Inches.	Inches.	
Burma	97·60	93·84	+3·76	+4	0·33	2·96	−2·63	−89
Assam	72·75	73·26	−0·51	−1	0·63	1·30	−0·67	−52
Bengal	68·19	59·84	+8·35	+14	0·09	0·91	−0·82	−90
Chota Nagpur	52·52	47·49	+5·03	+11	0·23	0·71	−0·48	−68
Bihar	52·49	43·50	+8·99	+21	0·03	0·31	−0·28	−90
North-Western Provinces and Oudh.	41·75	34·70	+7·05	+20	0·49	0·40	+0·09	+23
Punjab	12·85	15·15	−2·30	−15	0·63	0·57	+0·06	+11
Central Provinces	45·61	45·80	−0·19	0	0·09	0·79	−0·70	−89
Central India	36·70	40·95	−4·25	−10	0·28	0·73	−0·45	−62
Rajputana	12·16	18·66	−6·50	−35	0·45	0·37	+0·08	+22
Berar	26·31	37·48	−11·17	−30	0·12	1·18	−1·06	−90
Bombay	41·59	41·27	+0·32	+1	0·76	0·89	−0·13	−15
Madras	34·84	34·20	+0·64	+2	11·62	7·55	+4·32	+57

Although the rainfall was in considerable defect in Berar and North Bombay, it was favourably distributed in every respect. The same was the case over a large part of the Punjab, and the only areas in which the rainfall was insufficient for the crops were parts of Rajputana (chiefly the western and central districts) and of the South and South-East Punjab.

The preceding data indicate generally the favourable character of the rainfall of the monsoon period from the end of May to the middle of October over the whole of India.

They also show that Madras received favourable and satisfactory rain during the period of the retreating monsoon. The rainfall during that period was, on the other hand, very scanty over the whole of North-Eastern and Central India and the North Deccan. Over the greater part of that area the total rainfall of the period was less than 20 per cent. of the normal.

The later or retreating south-west monsoon rains terminated in Southern India slightly earlier than usual in the beginning of December. The cold weather rains began in the last week of December in the Punjab and the adjacent mountain districts to the north and east.

November 1898 was even finer and more settled than usual in North-Western and Central India and the Deccan and the mountains to the north-west and north of the Punjab, and little or no snow fell in the Himalayan area during the month. Temperature was in considerable excess in the Central Provinces, Berar, North Bombay and Central India.

December was also finer than usual over the greater part of Northern India. Fine weather held steadily until the last week of the month when a disturbance gave moderately heavy snow in the Punjab hill districts. The chief feature of the month was the abnormally high temperature in the large central area including Khandesh, the Deccan, Berar, Hyderabad and the Central Provinces in which it ranged between 4° and 8° above the normal. The month was practically rainless except in South Madras which had moderate to heavy rain and in the greater part of North-Western India which had light to moderate rain.

The following is a brief summary of the chief features of the meteorology of India during the past five months:

January was remarkably free from cold-weather storms. Weather was disturbed at the commencement of the month, and snow fell from the 2nd to the 6th in the Punjab hills. The fall was heavy in the Simla hills and in Almora. Fine clear weather prevailed generally during the remainder of the month, and the chief features of the meteorology of the month were abnormal dryness of the air, deficient cloud and scanty rainfall. A strongly marked cool wave affected Northern India after the snowfall of the first week of the month. A second cool wave advanced across Northern India between the 15th and 18th. The mean temperature of the month, both by day and night, was more or less below the normal over nearly the whole of India. The deficiency was considerable over the whole of Northern and Central India, ranging between 2° and 5° for the month.

February was somewhat more disturbed than usual, due to a succession of five depressions and cold-weather storms which advanced across Northern India during the period. With one exception, they were very feeble and gave very little rain in the plains except in Upper India, Bengal and Assam. The rainfall of the month was hence very scanty and below the normal—more especially in Upper India. Pressure was in considerable defect over the whole of India by amounts averaging ·04 inch. Temperature was above the normal except in parts of Burma. The excess was considerable in North-Western India, ranging between 2° and 5°, and was small in North-Eastern India and the Peninsula. The air was much drier than usual—more especially in the interior, including Rajputana, Central India, Berar, the Central Provinces and North Deccan.

March.—A series of shallow depressions similar to those of the preceding month advanced across Northern India. They gave little or no rain except in Baluchistan, the North Punjab, the Punjab hills, Bengal and Assam. The month was much drier than usual—more especially in Berar, the Central Provinces and Deccan. Temperature was in general excess, the variations from the normal being small in the Peninsula, Burma and Bengal and moderate to considerable in amount (2° to 5°) in North-Western and Central India. The mean pressure of the Indian area was ·01 inch below the normal. Pressure was, as in January, relatively in slight defect in North-Eastern and Southern India and in slight excess in North-Western and Central India. The abnormal temperature features of the month were similar to those of the preceding month.

April.—The mean pressure of the Indian area only differed by ·001 inch from the normal. The abnormal features of the month were practically opposite to those of the preceding month. Pressure was locally in defect over the greater part of North-Western India and also in Burma and in excess in North Eastern India. The chief feature of the weather of the month was the occurrence of

unusually heavy rainfall over the south and centre of the Peninsula, accompanying series of thunderstorms of unusual frequency and intensity. The rainfall of the month was hence very largely above the normal over the whole of Madras, the Deccan and West Coast and to a less extent in North-Eastern India. Temperature was hence considerably below the normal over the whole of the interior of the Peninsula by amounts ranging between 2° and 5°. It was in slight excess in Upper India and in moderate excess in Burma.

May.—The mean pressure of the Indian area was slightly below the normal (·018 inch). Pressure was, relatively to the general condition, more or less in defect in North-Eastern India and Burma and in Upper India and was in excess in the remainder of India. This contrast of conditions between Upper and North-Eastern India and Western India, it may be noted, almost invariably obtains in years of strongly marked hot-weather conditions—more especially after milder winters than usual in the Western Himalayas. The local deficiency was most marked in Bengal and the West Punjab, and the local excess greatest in the western half of the Peninsula. The following gives data for stations in the areas of greatest excess and deficiency of pressure:

Station.	Pressure anomaly in May.			Station.	Pressure anomaly in May.		
	1899.	1898.	1897.		1899.	1898.	1897.
	Inch.	Inch.	Inch.		Inch.	Inch.	Inch.
Saugor Island	—·041	—·013	—·010	Khandwa	+·032	+·023	+·021
Chittagong	—·032	—·008	+·001	Ratnagiri	+·033	+·027	+·033
Narayanganj	—·030	—·009	—·005	Goa	+·039	+·034	+·034
Mymensingh	—·031	—·012	—·008	Mangalore	+·032	+·013	+·018
Dhubri	—·035	—·017	—·004	Coimbatore	+·030	+·005	+·007
Peshawar	—·046	—·002	+·011				
Dera Ismail Khan	—·042	?	—·017				
Mooltan	—·043	+·008	—·027				

The pressure variations in May 1887, May 1894, May 1895, May 1896, May 1897 and 1898 were similar in general character to those of the corresponding month of the present year, the chief difference being that they were slightly more marked in the present year than in those preceding years. The large local deficiency in the West Punjab is a special feature of the present year.

The position of the trough of low pressure varied very considerably during the month. At the end of the month its axis was defined by the stations of Calcutta, Hazaribagh, Allahabad, Sirsa and Dera Ismail Khan, and was hence further north than usual.

The mean temperature of the month was in excess over the whole of Northern and Central India. The excess was large in the Punjab, North Bengal and Cachar. The excess averaged 5°·3 in the Punjab, 3° in North Bengal and 2½° in Cachar. It was in very slight defect in the Peninsula and in slight to moderate defect in Burma, due to the frequent general rain during the month in that province.

Frequent rain was received in Burma and occasional rain (much below the normal) in Assam and parts of Bengal.

The rainfall of the month was in excess in Burma and in considerable to large general defect in parts of Bengal and in Assam.

The meteorology of India during the past five months has been characterized by strongly marked abnormal features.

The following states the most important:

(1) Pressure was from January to May below the normal over the Indian area, as is shown by the following statement:

Month.	Mean 8 A.M. pressure anomaly of Indian area.					
	1899.	1898.	1897.	1896.	1895.	1894.
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
January . .	—·003	+·017	—·003	—·003	—·009	—·020
February . .	—·040	—·077	—·036	—·012	+·009	+·010
March . .	—·010	—·013	—·020	—·022	—·018	—·017
April . .	—·001	—·017	+·038	—·032	+·013	—·019
May . .	—·018	—·008	—·005	+·013	—·007	—·023

(2) Pressure has been, during the greater part of the period, in slight defect in Northern India and Burma. The following table gives data in illustration of this feature:

Division.	Mean 8 A.M. pressure anomaly in								
	October 1898.	November 1898.	December 1898.	January 1899.	February 1899.	March 1899.	April 1899.	May 1899.	Mean of period.
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
Burma . . .	—·004	+·003	+·007	—·003	+·012	—·006	—·011	—·009	—·001
Assam . . .	+·015	+·003	—·019	—·007	+·003	—·002	+·010	—·026	—·003
Bengal . . .	+·004	+·008	+·002	—·005	—·007	—·014	+·008	—·023	—·003
Bihar	+·005	0	—·016	—·002	—·007	—·016	+·013	—·016	—·005
Chota Nagpur . .	+·006	+·001	—·008	—·020	—·003	—·010	+·013	+·001	—·003
North-Western Provinces and Oudh .	+·004	—·008	—·010	—·003	—·012	—·009	+·007	—·003	—·004
Punjab . . .	—·006	—·003	—·008	+·010	—·009	+·003	—·003	—·020	—·005
Rajputana . . .	—·005	—·016	—·017	+·009	—·007	+·017	—·020	+·008	—·004

(3) Pressure has been generally in local excess in the Peninsula, Kathiawar, Berar, the Central Provinces and Central India, and there was a marked tendency to the establishment of an area of locally high pressure in Berar and the western districts of the Central Provinces in February, March and May. The area of greatest excess has varied slightly from month to month. The following gives data:

Division.	Mean 8 A.M. pressure anomaly.								
	October 1898.	November 1898.	December 1898.	January 1899.	February 1899.	March 1899.	April 1899.	May 1899.	Mean of period.
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
Kathiawar (Rajkot) .	—·013	—·023	+·004	+·017	+·002	+·022	—·018	+·024	+·002
South-West Rajputana (Deesa) . . .	—·004	—·016	—·006	+·013	—·005	+·014	—·029	+·022	—·001
Central India . .	+·006	—·007	—·006	+·005	+·007	+·016	—·004	+·016	+·004
Central Provinces .	+·014	+·009	+·002	+·003	+·005	+·013	+·005	+·009	+·008
Berar . . .	—·008	+·007	+·009	+·012	+·021	+·025	+·021	+·026	+·016
West Coast . .	—·018	—·004	+·002	—·003	+·011	+·003	—·001	+·029	+·002
Bombay Deccan .	—·002	+·002	+·003	—·004	+·006	+·009	+·001	+·028	+·005
South India . .	—·012	—·002	+·015	—·011	+·003	—·002	—·008	+·020	0
Ceylon . . .	—·028	—·020	—·006	—·008	+·014	0	—·011	+·021	—·005

These conditions were established at the end of the rains in December and have been fairly persistent up to the present time.

(4) Pressure was generally in relative excess at the hill stations, or the vertical pressure anomalies were positive in February, March and May and in relative defect in January and April. On the mean of the period—January to May—pressure has been in moderate to considerable relative excess. The following gives data for seven pairs of stations :

Pair of stations.	Mean 8 A.M. vertical pressure anomaly in					
	January 1899.	February 1899.	March 1899.	April 1899.	May 1899.	Mean of period—January to May 1899.
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
Leh and Lahore	+·019	+·118	+·063	—·013	+·075	+·052
Simla and Ludhiana	—·043	+·046	+·042	—·001	+·047	+·018
Murree and Peshawar	—·040	+·020	+·007	—·007	+·058	+·008
Chakrata and Roorkee	—·024	+·048	+·048	—·005	+·047	+·023
Ranikhet and Bareilly	—·026	+·035	+·038	—·006	+·025	+·013
Darjeeling and Dhubri	—·032	+·021	—·012	—·033	+·039	—·003
Quetta and Jacobabad	+·010	+·057	+·035	+·032	+·043	+·035

(5) Temperature is, on the mean of the whole period, in excess over North-Western India. It was in general excess in February, March and May. The excess was moderate to considerable in North-Western India and large in Upper India in May. The disturbed weather of January and April reduced it below the normal. The following gives comparative data of the variations of the mean daily temperature for the whole of Burma, Northern and Central India and the Peninsula, month by month, from January to May 1898.

Province or Division.	Variation from normal of mean daily temperature.					
	January 1899.	February 1899.	March 1899.	April 1899.	May 1899.	Mean of period.
	°	°	°	°	°	°
Burma	0	—0·4	+0·9	+1·0	—1·2	+0·1
Assam	—2·7	+0·1	—0·1	—1·2	+1·9	—0·4
Bengal	—2·8	+0·7	+1·2	—0·8	+1·7	0
Orissa	—1·2	+1·1	+1·7	—1·7	0	0
Bihar	—3·3	+1·2	+1·2	—1·7	+1·6	—0·2
Chota Nagpur	—2·6	+1·5	+3·0	—2·1	+0·6	+0·1
North-Western Provinces and Oudh	—3·4	+2·2	+2·6	—1·2	+1·8	+0·4
Punjab	—3·2	+2·4	+2·9	0	+5·3	+1·5
Sind	—3·1	+2·4	+1·1	+1·4	+1·9	+0·7

Province or Division.	Variation from normal of mean daily temperature.					
	January 1899.	February 1899.	March 1899.	April 1899.	May 1899.	Mean of period.
	°	°	°	°	°	°
Rajputana	—3·0	+3·1	+3·1	+0·9	+2·7	+1·4
Gujarat	—3·6	+1·4	+0·2	+0·4	—0·6	—0·4
Central India	—4·0	+1·7	+1·9	—0·1	+0·3	0
Central Provinces . . .	—2·4	+1·4	+1·8	—1·3	+0·5	0
Berar	—2·1	+1·4	+2·5	—1·3	+0·3	+0·2
West Coast	—1·3	+0·2	+0·4	—1·1	0	—0·4
Bombay Deccan . . .	—2·3	0	+0·7	—2·5	—0·6	—0·9
Mysore	0	+0·9	+0·3	—1·5	—1·8	—0·4
Madras Coast	+0·1	+0·5	—0·4	—0·4	+0·8	+0·1
Madras Deccan . . .	+0·1	+1·3	0	—2·6	—0·7	—0·4
South India	—0·8	+0·1	—0·9	—3·8	—0·4	—1·2

(6) The air has been much drier than usual during the greater part of the period over nearly the whole of the interior and more especially in Rajputana, Central India, Berar, the Central Provinces and Deccan. The decreased humidity was in part due to increased temperature and in part to the presence of a smaller amount of aqueous vapour than usual in the air.

The following gives comparative data for fourteen representative stations:

Station.	Variation from normal of mean relative humidity (*i.e.*, percentage of saturation).						Mean of period.
	November 1898.	December 1898.	January 1899.	February 1899.	March 1899.	April 1899.	
Hazaribagh	—4	—2	+1	—2	—9	+4	—2
Allahabad	—7	—9	—3	—6	—6	+1	—5
Roorkee	0	+3	—5	—7	—10	—5	—4
Meerut	—4	—4	—13	—4	—7	—5	—6
Lahore	—5	—2	—9	—3	—9	0	—5
Jeypore	—12	0	—15	—7	—9	—1	—7
Jacobabad	—4	—1	—10	+3	—1	—6	—3
Kurrachee	—12	—13	—11	+2	+2	—3	—6
Deesa	—3	+8	—10	—4	—5	—3	—3
Mount Abu	—1	+4	—9	—4	—7	—2	—3
Khandwa	—8	—6	—15	—11	—13	—3	—9
Akola	—10	—7	—17	—5	—10	+9	—7
Hyderabad (Deccan)	—3	0	—10	—5	—10	+4	—4
Bellary	—5	—2	—12	+3	—3	+3	—3

(7) The distribution of cold and hot weather rainfall has been unusual. The rainfall of both seasons was slightly above the normal in Bengal and Bihar. The cold weather rainfall was in considerable to large defect in the Punjab, Sind, Rajputana, Gujarat, Central India, the Central Provinces and Berar. Over the greater part of that area practically no rain fell. The rainfall was in excess in the hot weather season over nearly the whole of Northern India and Burma. The excess was considerable (over 30 per cent.) in Bihar, Chota Nagpur, Orissa, Sind and Berar.

The following gives comparative data showing its distribution in both seasons:

Province or Division.	Cold weather rainfall (January and February 1899).				Hot weather rainfall (from 26th February to 20th May 1899).			
	Average actual.	Average normal.	Variation from normal.	Percentage variation from normal.	Average actual.	Average normal.	Variation from normal.	Percentage variation from normal.
	Inches.	Inches.	Inches.		Inches.	Inches.	Inches.	
Burma	0·06	0·21	—0·15	—71	8·59	6·96	+1·63	+23
Assam	2·78	2·18	+0·60	+28	24·73	27·16	—2·43	—9
Bengal	1·80	1·35	+0·45	+33	10·52	9·13	+1·39	+15
Bihar	1·70	1·25	+0·45	+36	3·12	2·12	+1·00	+47
Chota Nagpur	0·98	1·41	—0·43	—30	4·05	3·04	+1·01	+33
Orissa	0·46	1·18	—0·72	—61	7·85	4·45	+3·40	+76
North-Western Provinces and Oudh	0·89	1·17	—0·28	—24	1·32	1·06	+0·26	+25
Punjab	0·77	1·87	—1·10	—59	1·00	2·16	—1·16	—54
Sind	0·01	0·71	—0·70	—99	0·87	0·42	+0·45	+107
Rajputana	0·01	0·56	—0·55	—98	0·37	0·65	—0·28	—43
Central India	0·19	0·98	—0·79	—81	0·30	0·54	—0·24	—44
Gujarat	0	0·08	—0·08	—100	0·11	0·09	+0·02	+22
Central Provinces . . .	0·34	0·77	—0·43	—56	1·21	1·18	+0·03	+3
Berar	0·23	0·65	—0·42	—65	1·47	0·56	+0·91	+163

Summary.—The following is a summary of the chief features of the meteorology of India during the past five months, which are most likely to influence the advance of the monsoon currents and the distribution of the monsoon rainfall:

(1) The snowfall of the past winter has undoubtedly been much less than usual over the whole of the Western Himalayas and also in Afghanistan, Baluchistan and Persia. It was probably in local excess in Kashmir and also in Kumaon and Garhwal. The snowfall was distributed fairly throughout the season, and there is no abnormal accumulation at the end of May except perhaps on the higher ranges in Kashmir.

(2) The snowfall of the past winter has been heavier than usual in the Sikkim and Assam Himalayas.

(3) The pressure conditions in India during the past five months were such as accompany higher temperature in Northern India and less snowfall than usual in the Western Himalayas. The chief features, which have been fairly persistent, are (*a*) general

deficiency of pressure, (*b*) local deficiency in Northern India and Burma, most marked in Bengal and the Punjab, and (*c*) local excess in the Peninsula and Central India, greatest in Berar, the Konkan, Malabar and West Deccan.

(4) The temperature conditions during the past five months were such as usually accompany a drier winter than usual in the Himalayan area—more especially in the lower and middle ranges. Temperature was in moderate excess in February and March in Northern and Central India and in large excess in Upper India in May.

(5) The air has been throughout nearly the whole season much drier than usual and skies remarkably free from cloud.

(6) The air movement was more vigorous than usual in March and May, due to the intensified thermal conditions of the period in the interior of India.

(7) The snowfall in the Western Himalayan area has been of such a character as not to impress any conditions upon the pressure distribution, temperature and air movement in Northern and Central India unfavourable to the early or full extension of the monsoon currents in their progress northwards from the Equator.

(8) The influence of heavy snowfall in the Assam Himalayas has not yet, in the absence of sufficient reliable data, been investigated.

It may be noted that some of the abnormal features of the meteorology of India during the past seven months have been related to abnormal conditions prevailing in Persia and South-Eastern Europe. Anti-cyclonic conditions obtained to a most unusual degree in Southern Europe from November onward, and, as a consequence, cool dry north-west winds prevailed in Persia with remarkable persistence from November to February. This abnormal air movement extended across Baluchistan and the north of the Arabian Sea into North-Western India, and undoubtedly contributed to the unusual dryness of the air and freedom from severe cold-weather storms of the period in Northern and Central India.

COMPARISON WITH PREVIOUS YEARS.

During the past twenty-one years the snowfall in the Himalayas was below the average in the years 1879, 1880, 1881, 1882, 1890, 1892, 1896 and 1898. The deficiency in 1890 and 1892 was very large, and these years are not strictly comparable with the present year.

The conditions of the years 1881 and 1896 also differed largely from those of the present year and are not comparable.

The following gives a very brief statement of the chief features of the meteorology of the years 1879, 1880, 1882, 1887, 1890, 1892, 1894 and 1895 :

1879.—The snowfall was very light and considerably below the normal in the North-Western Himalayas. Very heavy snow had fallen during the preceding winters of 1876-77 and 1877-78. Pressure was generally in defect, the deficiency being greatest in April and May, when it averaged ·03 inch for the whole of India. The local variations of pressure were not strongly marked or persistent.

In the month of May pressure were locally in defect in the west of the Peninsula, more especially in the Gulf of Cambay, and was in excess in Upper India. Temperature was in excess in January, February, April and May. The excess was large in amount in April and May, and averaged 4° in the Punjab, where it was greatest. The rains set in over Bengal fully on the 14th June and commenced at Bombay on the 1st, but were not strong before the 24th. The rainfall of the south-west monsoon period was more or less in excess over the whole of India, except the Punjab, where it was in moderate defect, and in parts of Bengal and Madras, where it was slightly below the normal. The rains ceased in Upper India on the 29th September.

1880.—The winter snowfall was in moderate defect in the Western Himalayas and the cold-weather rainfall below the normal to a moderate extent in Northern India. Pressure was in general defect from January to May. The deficiency was largest in January (·033″) and averaged ·023″ for the whole period. Pressure was locally in excess in the Peninsula, the excess being most marked at the west coast stations from Bombay to Calicut. It was locally deficient in Northern India, the deficiency being most marked in the Punjab, where it averaged ·05″. These large local pressure variations were fairly persistent from March to May. The excess was most marked in the Punjab during the whole period. It averaged $7\frac{1}{2}°$ in March, 6° in April and $3\frac{1}{2}°$ in May. The rains commenced on the 2nd of June in Bengal and on the 6th at Bombay, but both currents were at first feeble. Very heavy rain fell in the Punjab in July, and the weather was stormy with much snow in the hill districts This was followed by a prolonged break in the rains, lasting throughout nearly the whole of August. The rains ceased in Upper India on the 24th September. The rainfall of the south-west monsoon period was largely in defect in the Punjab, North-Western Provinces, Rajputana and Central India, and in moderate defect in the Central Provinces and Berar. It was in excess in North-Eastern India, Burma and Madras.

1882.—The snowfall of the winter of 1881-82 in the Western Himalayas was below the normal (probably to a slight extent) and the winter rains in Northern India in moderate defect. The variations of pressure and temperature from the normal during the pre-monsoon period—January to May—were small and apparently of little importance. They, however, indicated the prevalence of approximately normal conditions. The rains commenced on the 2nd June at Bombay and on the 11th June in Bengal. The Bombay current was strong and gave very heavy rain in June and July. The Bengal current was feeble in these two months, but was vigorous in August. The rains ceased on the 15th September in Upper India. The rainfall in the districts and provinces dependent on the Bombay current was abundant, whilst North-Eastern India (*i.e.*, Assam, Bengal, Bihar and the North-Western Provinces) obtained smaller amounts than usual. The deficiency was small, except in some parts of Bengal.

1887.—The cold weather was unusually free from cold-weather storms. Although little rain fell in the plains of Northern India, moderately heavy snow is stated to have fallen in January and March in the Western Himalayas. March and April were warmer than usual in North-Western India and the Central Provinces, and May was an excessively hot month in Upper and Central India. Pressure was in slight to moderate defect on the average of the whole of India during the period—January to May. It was, relatively to the general condition, in considerable defect in Northern India in May, the deficiency being large in Upper India (—·05″) and moderate in North-Eastern India. It was in considerable excess in the west of the Peninsula, the excess averaging ·06 inch in the Konkan and Malabar coast districts. The mean temperature of the month of May was 6° above the normal in the Punjab and 3° in the North-Western Provinces. The Bengal current set in earlier than usual at the end of May and the Bombay current about the normal time in the first week of June. Both currents gave fairly steady rain during the months of June, July and August. They retreated from Upper and Central India at the end of the third week of September. The monsoon rainfall was in slight defect in Arakan, Bengal, Assam and Orissa, normal in Burma and the Deccan and in excess over nearly the whole of North-Western and Central India and the Central Provinces.

1890.—The cold weather of 1889-90 was unusually dry in Northern India, and the snowfall in the Western Himalayas and Afghan mountains much below the normal amount. The snowfall in the Eastern Himalayas was also in slight to moderate defect. No rain fell in Rajputana in January and February 1890, and the North-Western Provinces and the Punjab received total average amounts of one-fifth and one-third of the normal amounts respectively. Temperature was considerably above the normal in January and February, the excess being greatest in Upper India, where it averaged $2\frac{1}{2}°$. The hot weather was also drier than usual, and temperature was in moderate excess, averaging in the

Punjab, where it was greatest, 1½°. Pressure was generally in defect over India during this period by moderate amounts. Pressure was locally in defect in Northern India, the deficiency being most marked in the north of the Bay. It was locally in excess in the Peninsula and North-West India, the excess being largest in Kathiawar, Gujarat, Berar and the North Bombay Deccan, where it ranged from ·03 inch to ·044 inch. The rains commenced on the Bombay Coast on the 1st June and in Bengal feebly on the 7th and fully on the 19th. The rainfall of the south-west monsoon period (June to October) was more or less in excess in Northern India, the Konkan, the Central Provinces and Hyderabad, the excess being greatest in Bihar and the North-Western Provinces. It was in moderate defect in Burma, Southern India and Ceylon and in large defect in Gujarat, Sind and Cutch and to a less extent in Western Rajputana. The rains ceased in Upper India on the 27th of September.

1892.—The cold-weather rainfall of 1891-92 was abnormally small in amount and in large defect in Upper India. Pressure was in general defect at the level of the plains and was in considerable relative excess at the hill stations. Temperature was above the normal over the whole of India during the cold-weather by amounts averaging 2°. The excess was greatest in the Central Provinces, Berar and Central India. The air was much drier than usual and cloud in general defect.

The hot-weather conditions were very strongly marked. Temperature was in general excess and was most largely above the normal in Upper India, where the maximum temperature of the whole period—March to May—averaged about 6° above the normal and the minimum temperature 3½°. Burma and Assam received much heavier rain than usual and Bengal its normal amount. Over the remainder of India with the exception of the west coast districts the season was unusually dry and the rainfall very small in amount and much below the normal of the period.

The chief features of the pre-monsoon distribution of pressure were a considerable local deficiency in Northern India, greatest in amount in Upper India and a moderate to considerable local excess in the west of the Peninsula and North Bombay.

The rains commenced in the first week of June on the west coast and advanced very rapidly to Upper India. The advance was not permanent and the current withdrew from North-Western and Central India on the 17th and 18th. A first advance of the monsoon winds occurred in Bengal in the second week of the month. This was followed by their withdrawal in the third week of the month, and dry westerly winds prevailed over the Gangetic Plain until the end of the month. The permanent advance of the monsoon currents took place in the first week of July on the west coast and in the second week in Bengal. The currents extended rapidly over the whole of India and prevailed with unusual steadiness during the remainder of July and in August and September. The rainfall of the monsoon period—June to September—was more or less considerably in excess in the whole of India, with the exception of East, South and Central Bengal and Burma.

1894.—Moderate to heavy snow fell in the Western Himalayas in January and February. The snowfall in Baluchistan and Afghanistan was less than the normal. The snowfall did not come down to so low an elevation as in the preceding winter. Little or no rain fell in April and May. Temperature which was below the normal to a slight extent in Northern India during the cold weather increased rapidly in April and May and was largely in excess in the latter month, the area of greatest excess including Bihar, Chota Nagpur and the eastern districts of the Central Provinces. Pressure was in May locally in considerable defect in Northern India and in considerable excess in the western half of the Peninsula. The south-west monsoon rains set in somewhat later than usual during the first four days of June on the Malabar Coast. The monsoon currents advanced with unusual rapidity into the interior of Northern India and monsoon conditions were established over the whole of India before the end of the third week of the month. The rainfall was in general excess. It was very unequally distributed in June and July, due to the occurrence of a series of cyclonic storms of unusual

intensity. Those districts which received deficient rain in June and July, as a rule, obtained abundant and well-distributed rain in August and September, and the rainfall for the complete period—June to September—was on the whole favourable and well-distributed. The rains were, however, prolonged to the first week of November in the North-Western Provinces, and that area received a succession of downpours such as had not been experienced in those months during the previous fifty years.

1895.—The winter began earlier than usual in Baluchistan and Upper India. Numerous feeble disturbances in December and January gave heavy snow in the Punjab and Kashmir Himalayas. February was dry and temperature from 2° to 5° above the normal in Upper India. Weather was disturbed and showery over the hills in Upper India in March, but was abnormally dry in Cachar and East Bengal. It was disturbed with frequent series of thunderstorms in April in the Deccan and Southern India, and the rainfall of the month was in very large excess in these two areas. Burma received heavy rain in the last week of April (from a cyclonic storm) and in May. Pressure in May was in relative defect in Northern India and in excess in the Peninsula. The deficiency was greatest in the Punjab and the excess greatest in the Konkan and Malabar. Temperature was generally in excess—more especially in the Punjab (+6°) and Rajputana (+4°). The rains commenced nearly a fortnight later than usual on the Bombay Coast, and the monsoon currents were unusually feeble and unsteady.

The rainfall was in general defect in July. The currents withdrew from Upper India in the first week of September and from Bengal and Burma in the second week of October, and hence considerably earlier than usual over the whole of Northern and Central India. The monsoon rainfall was in defect over nearly the whole of India, and the deficiency was considerable in Upper and Central India.

GENERAL CONDITIONS IN THE INDIA MONSOON AREA AND INDIAN OCEAN.

The rainfall of the past year averaged 0·43 inch or one per cent. above the normal for the whole Indian area. It was pointed out in last year's forecast that the six years—1892-97—had been characterized by a cyclical variation of rainfall more prolonged in its period and of larger amount than has probably occurred in India during the present century. It was also stated in the forecast that the cycle was probably completed in 1897, and that a period of fairly normal conditions might be expected for some years in the Indian monsoon and the south-east trades region. This inference was in accordance with fact last year.

The experience of the cyclical period—1892-97—in India emphasized the necessity of considering the variations in the strength of the south-east trades circulation.

Theory indicates that any large and persistent variation in the strength of the south-east trades would be reproduced in the strength of the south-west monsoon. The variations in the strength of the south-east trades have been probably the chief or primary factor in determining the variations in the south-west monsoon in India during the past seven years. It is hence desirable to ascertain the chief meteorological features of the areas dominated by the south-east trades during the past three or four months, in the hope that this information may give a valuable indication, at the present time, of the probable strength of the approaching monsoon. The following is a summary of the information received, partly by telegrams from the Seychelles, Zanzibar, Mauritius and Cape Town and partly from the logs of ships regarding this important factor :

Seychelles.—The weather telegrams received during May from this station indicate that pressure was slightly higher than usual during the month, but normal at the end of the month. Winds were unsteady at the beginning of the month, but steady from south-east and stronger than usual during the last fortnight of the month. The weather at the end of the month was squally and showery. Vessels arriving from Madagascar reported stronger south-east trades than usual.

Zanzibar.—Pressure was above the normal to a slight extent throughout the month. Winds were normal in direction and somewhat stronger than the normal.

Mauritius.—Pressure was normal during the month, and gradients were normal or very slightly stronger than usual in the south-east trades region at the end of the month. Winds averaged about 20 per cent. above their normal velocity. The rainfall of the month was below the normal.

Logs of ships.—The information received up to the end of May from ships crossing the Equatorial belt of the Indian Ocean is very scanty. At the beginning of April south-east trade winds extended as far north as Lat. 8° S., and hence considerably further north than at the same date in the previous year. They advanced to Lat. 3° S. in the first week of May and to the Equator in the third week of the month. Light variable winds as usual obtained over a wide belt to the north of the south-east trades region and light to gentle north-west to west-south-west winds over the south and centre of the Arabian Sea up to the 15th May.

The mail steamer *Clyde* had moderate to strong monsoon winds in the last week of the month between Long. 54° and 59° E. The S.S. *Devonshire* on her passage from Mombassa to Bombay had squally weather with unsteady winds and much rain, thunder and lightning as far north as Lat. 5° N. in the south-west of the Arabian Sea. The China mail steamer *Coromandel* in her passage from Penang to Colombo (from the 20th to the 24th May) had moderate to strong south-west winds and frequent heavy rain squalls.

The information indicates that the south-east trades were probably slightly stronger than usual at the end of the month, and that conditions were favourable for their early extension as south-west monsoon winds into the Arabian Sea.

FORECAST OF THE SOUTH-WEST MONSOON OF 1899 IN INDIA.

In the preceding pages have been given, for future reference, the whole of the available data utilized in the preparation of the forecast.

Brief summaries of the more important features of the snowfall in the Himalayan area during the past winter, of the meteorology of India and the adjacent countries to the north-west and of the Indian Seas and the south-east trades region are given in pages 14, 15, 16, 24, 25, and 29.

Ordinary readers are referred to these summaries as containing the more important facts upon which the forecast is based.

As was pointed out in last year's forecast, the remarkable period (chiefly shown by cyclical variation of rainfall) through which India has recently passed terminated in 1897, and a period of fairly normal conditions appears to be now probable for two or three years at least.

The information from the Seychelles, Zanzibar and Mauritius, although very limited, indicates that the strength of the south-east trades, which is an important factor is above the normal, but to what extent cannot be judged.

The summary of the snowfall information indicates that in the Eastern Himalayas the snowfall has been greater than usual. Similar heavy snowfall was reported to have been received in the Assam Himalayas in the years 1887 and 1893. The monsoon rains were heavier than usual in both years, generally in India and also locally in Assam in 1893. In the absence of more definite and accurate information, it can only be accepted as probable that heavy snowfall in the Assam Himalayas exercises little influence on the distribution of the monsoon rainfall.

The snowfall in the Western Himalayas has undoubtedly been, on the whole, more or less below the normal. The deficiency was marked in the lower and middle ranges, and the extent of snow-clad surface is at the present time hence almost certainly not above and is probably below the normal. This is strongly confirmed by the pressure and temperature conditions in Upper India. The only unfavourable feature has been the frequent occurrence of light snow in March and April. Untimely snow in April and May chiefly affects the Bombay current. It usually retards the advent of that current more or less, and affects its strength unfavourably during the early stages (chiefly in the month of June). It is, however, very probable that any influence this late snowfall in April may have is very slight.

The most noteworthy feature of the past cold weather has been the scanty rain and snow in Baluchistan and Afghanistan and also in Persia. The precipitation in the Persian area (which occurs chiefly in the winter) has, so far as can be judged from the data of the four stations which supply the Meteorological Department with observations and weather telegrams, been more or less below the normal continuously during the past five years. The deficiency has been large and marked during the past two years. The conditions in Persia apparently exercise little direct influence on the distribution of the monsoon rainfall. They have, however, an important bearing, as they indicate that the deficient snowfall in the Western Himalayas, Afghanistan and Baluchistan during the past winter has not been due to local conditions in North-Western India, but to conditions extending over a very much larger area and hence probably of great persistence and importance.

Taking the above facts into consideration, it is very probable the monsoon currents will be at least of normal strength.

Judging only *from the conditions in India itself and the known conditions in the Indian Seas*, it is on the whole very probable that the monsoon currents will be of normal strength, and probably they will be somewhat stronger than usual. The Bombay current is more likely to be above its normal strength than the Bay current, but the probabilities for this are small, not exceeding 2 to 1.

Assuming that the currents will be of normal strength, the comparison with previous years of similar conditions (more especially 1880, 1887, 1892 and 1894) indicates that it is probable they will set in about the normal dates on both the Bengal and Bombay Coasts.

The rains will probably commence not later than the end of the first week of June on the Bombay Coast and in the latter part of the second week or the beginning of the third week of June on the Bengal Coast.

The chief features or local conditions in India which have to be taken into account in estimating the probable distribution of rainfall during the approaching monsoon due to normal or slightly stronger monsoon currents than usual are :

(1) The distribution of the winter snowfall in the mountain areas to the north and north-west of India (*vide* page 14).

(2) The abnormal features of the pressure, temperature and humidity conditions of the past five months and more especially in May (*vide* pages 21-25).

(3) Heavy local rainfall in Burma and Bengal in April and May 1899 and in the Peninsula in April. The former generally accompanies drier seasons than usual in Upper India, and although of unusual amount in the present year, it is not exceptional in character and is hence of no especial importance. Heavy rainfall in the Peninsula occurred in April 1878, May 1886 and April 1895. The rainfall of the monsoon of 1895 was chiefly determined by the causes producing the cyclical variation of 1892-97 and was considerably below the normal. The rains in 1878 and 1886 were generally favourable and in excess.

The following inferences respecting the distribution of the south-west monsoon rains of 1899 are deduced from the comparison of the antecedent conditions of the present year with those of previous years and are based chiefly on the facts and data stated above :

(1) The conditions in the Indian Seas and the Indian Ocean are, so far as can be ascertained, satisfactory and favourable, and indicate that the conditions in the south-east trades region are at least normal, and that the air movement in that area is somewhat stronger than usual.

(2) Conditions are favourable to the prevalence of monsoon currents of at least normal strength in the Bay of Bengal. The rains will probably commence slightly before or about the normal date in Bengal (*i.e.*, the 15th of June).

(3) Conditions are favourable to the prevalence of monsoon currents of at least normal strength in the Arabian Sea. They are also slightly more favourable in that sea than in the Bay. The influence of the late snowfall in April will very probably be very slight, and, so far as can be judged, the monsoon ought to set in on the Bombay Coast before the 8th of June.

(4) Conditions are favourable in Burma, and it will probably receive at least normal rain. The rainfall is more likely to be in excess in Lower Burma than in Upper Burma.

(5) Conditions are slightly unfavourable in North Bengal and Assam. The rainfall on the mean of the whole area will very probably not be above the normal and probably be in slight to moderate defect.

(6) Conditions are favourable in West, South and East Bengal—more especially in the two latter areas, and the rainfall of the south-west monsoon period will be very probably normal and probably in excess in South and East Bengal, and normal or in slight defect in West Bengal and Orissa.

(7) Conditions are slightly unfavourable in Bihar and Chota Nagpur, due to the deficiency of pressure in Bengal and Assam, and the rainfall on the average of the whole area will very probably not be above the normal and probably be in defect to a slight extent. Conditions are slightly more favourable in Chota Nagpur than Bihar.

(8) Conditions are, on the whole, favourable for normal rain in the North-Western Provinces. There is a slight probability, based chiefly on the pressure conditions in the Punjab, that the rainfall of the whole area may be in slight to moderate excess. It is more probable the rainfall will be in excess in the western than the eastern districts.

(9) Conditions are favourable in the Punjab. The pressure conditions of May (more especially the deficiency in the West Punjab) strongly resemble those of May 1880, 1892 and 1894. Comparison with these years indicates that the monsoon rainfall of the present year will probably be above the normal. The character of the rainfall in this area, however, depends chiefly on the general strength of the monsoon and not on the local conditions, and these conclusions should be suitably modified if the monsoon turns out to be much weaker than is anticipated in the forecast, in which case the rainfall may be below the normal to a moderate extent in the West and Central Punjab and normal or in slight defect in the East Punjab.

(10) Conditions are, on the whole, favourable in Rajputana—more especially in the eastern and central districts, due to the same conditions as in the Punjab. The monsoon rainfall will hence very probably be at least normal in the eastern and central districts and probably in moderate excess. It will probably be about normal in the western states. The rainfall in these areas, as in the Punjab, depends chiefly on the general strength of the monsoon, and hence, if the Bombay monsoon current be weak, the rainfall will be normal or in slight defect.

(11) Conditions are about as favourable in Central India as in the North-Western Provinces, and it is probable that it will receive at least normal rainfall. The rainfall is more likely to be in excess in the eastern than the western states.

(12) Conditions are, on the whole, favourable in the Central Provinces and to a slightly less extent in Hyderabad. It is hence probable that they will receive at least normal rainfall. The conditions are more

favourable in the eastern than the western districts of the Central Provinces, and it is hence probable that the eastern districts may receive rainfall in slight to moderate excess of the normal.

(13) Conditions are not quite so favourable in Berar and Khandesh, and the rainfall in these areas will probably not be above the normal and may be in slight defect. They are also slightly unfavourable in the West Deccan, and that area will very probably not receive more than its normal fall and probably less.

(14) The conditions in the west coast districts are such as are in normal monsoons associated with at least normal rainfall. It is hence very probable that the rainfall of the present year's south-west monsoon will be at least normal in those districts, and probably it may be in slight to moderate excess.

(15) The variations of the rainfall in the North Madras coast districts are in at least five years out of six similar to those of Orissa and the Central Provinces. Conditions appear to be on the whole favourable, and it is probable those districts will receive about normal rain.

(16) A comparison of the conditions in the Madras Deccan, Mysore and the Carnatic with those of similar years indicates that the rainfall during the period—June to August—will probably be in slight defect—more especially in Mysore. It is, however, very difficult to forecast for this part of India, as rain in the southern half of the Peninsula during the monsoon proper occurs chiefly during the intervals of breaks in the rains of Northern India, and is hence essentially of irregular occurrence.

It should be carefully noted that the preceding probabilities are obtained on the assumption that the currents will be slightly stronger than usual, and that they will require to be suitably modified, if the monsoon currents should be weaker than usual. It should also be noted that the chances for an inference stated to be very probable are at least 5 to 1 and for an inference stated to be probable are at least 5 to 2.

The general conclusions are, 1st, that the rainfall over the Indian area during the approaching monsoon will on the average of the whole area probably be slightly above the normal, 2nd, that it may be in slight to moderate local defect in Assam, North Bengal, Bihar, Berar, the Bombay Deccan and Mysore, 3rd, about normal in Chota Nagpur, Orissa, West Bengal, the North-Western Provinces, the Central Provinces, and Hyderabad, and 4th, in slight to moderate excess in Lower Burma, South Bengal, the Punjab, Rajputana and Central India.

As already pointed out, these conclusions should be suitably modified if the monsoon currents should turn out to be considerably stronger or weaker than was anticipated in the forecast from the very imperfect and scanty data available on this point.

It is too early to estimate the probability of a longish break in the rains in July or August, but there are no indications at present of such an event.

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SIMLA;
Dated 6th June, 1899.

M. FINUCANE,

Offg. Secretary to the Government of India.

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GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE AND AGRICULTURE.

Memorandum on the snowfall in the mountain districts bordering Northern India and the abnormal features of the weather in India during the past year, with a forecast of the probable character of the south-west monsoon rains of 1901.

1. *It may be noted here that the greater part of this long memorandum, more especially the portions which give statements of the snowfall in the mountain areas to the north and north-west of India, summaries of the meteorological conditions in India during the past eighteen months, and all the available information of the meteorology of South Africa and other areas (indicative of the strength and character of the south-east trades), is chiefly intended for reference in the preparation of future forecasts and in any future investigations into the relation between the meteorology of India and the Oceanic area to the south.*

The summary of the snowfall information will be found in pages 16 to 18, the summary of the chief features of the meteorology of India during the past winter months in pages 31 and 32, the information relating to the Indian Ocean and South Africa in pages 34 to 39, and the forecast based on the whole of the available information in pages 40 to 44.

2. The present memorandum is drawn up in accordance with the practice of the past seventeen years, and includes, firstly, a brief summary of the information received from various officers relating to the snowfall of the past winter or cold weather in the Afghan mountains and the Himalayan area; secondly, a statement of the chief peculiarities or abnormal features of the meteorology of India during the past year; and, thirdly, a forecast of the probable character of the approaching south-west monsoon rains based on this information.

3. The forecast is based in part on the snowfall information and on the abnormal features of the weather during the past five months, and in part on a comparison with the meteorology of the previous twenty-four years, so far as it is available. It is necessary to point out that the forecast is a statement of probabilities and not of certainties, and that it is liable to error from the limitation and uncertainty of part of the data on which it is based. It has been drawn up after a consideration of all the available information, but it should, to use the words of the Famine Commission Report, *"be used with due caution."*

4. The monsoon forecasts, as at present issued, necessarily leave out of consideration two important points on which the agricultural value of the monsoon rainfall largely depends, *viz.*:

(1) the probability of the occurrence of a prolonged break in the rains in July or August;

(2) the probability of the unusually early termination of the rains in North-Western and Central India or in Bengal;

and are hence imperfect every year to that extent.

5. The chief features or conditions which influence and determine the extension and general strength of the south-west monsoon currents are as follows:

1st.—The amount and time of occurrence of the cold weather snowfall in the mountain districts adjacent to Northern India.

2nd.—The local peculiarities of the weather in India immediately antecedent to the advance of the monsoon currents across the coasts of Bombay and Bengal into the interior, and which, it is found, are generally initiated during the hot weather, and are frequently more or less persistent in character. These abnormal features are, on the whole, best estimated by means of the variations of pressure from the normal.

3rd.—Local peculiarities in the Bay of Bengal and Arabian Sea, over which the monsoon currents pass before they reach India; and

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probably also the Indian Ocean, which is the source of the massive current of the south-west monsoon in India.

The first of these conditions or factors is mainly influential in determining the northern limits of the monsoon rains, heavy and prolonged snowfall in the Western Himalayan area either preventing or delaying the extension of the monsoon current over Upper India during the rainy season. Heavy and untimely snowfall in April and May especially exercises a very powerful influence in this way.

The second factor determines those large local district or provincial variations of rainfall during the monsoon, which are evidently due to persistent local conditions or peculiarities, and not to general causes influencing the whole of India more or less.

The third and last factor is at least of equal importance with the preceding two, but it is that on which information is most difficult to obtain and is least in amount and longest in being received. In fact, information respecting the weather conditions in the Arabian Sea, Bay of Bengal or the Indian Ocean has hitherto been rarely received in time to be utilized in drawing up the annual forecasts. Special arrangements have been made to obtain telegraphic information from Zanzibar, Mauritius and the Seychelles in the hope that it might throw some light upon the conditions at present prevailing in the south-east trades region in the Indian Ocean.

6. A statement was given in last year's forecast of the bearing and influence of the meteorology of the Indian Ocean on the distribution of the monsoon rainfall in India. It appears to be desirable to repeat the following portion of that note:

"The rainfall of the period June to September or October in Abyssinia, the South Arabian highlands and Northern India is due to a common source. The whole area is intensely heated in May, but practically no rain falls in any part of these areas in that month. The solar action in India and the neighbouring land areas gives rise to meteorological changes which prepare for the advance of the monsoon currents, but which do not primarily and directly give rise to the advance.

"Before the advance occurs light unsteady winds prevail in May in the Arabian Sea. The advance commences in the neighbourhood of the Equator and is due to actions chiefly over the Indian Ocean, the result of which is that the current of the south-east trades is impelled across the Equator and thence northwards over the Indian Seas, and towards the heated regions in East Africa, South Arabia, India and the Malay Peninsula. The advance of the current is accompanied by heavy squalls with much rain and when fully accomplished gives strong steady humid winds for some months in the Indian Seas. These humid winds are determined to the regions named above and give frequent heavy rain, the distribution of which depends upon a variety of causes, but which is greatest in the coast and hill districts, more especially the Abyssinian highlands, the Himalayan mountain districts, the West Ghats and the Arakan and Tenasserim hill ranges and the coast districts of Burma, Bengal and Bombay.

"It is evident from a consideration of these facts and theoretical views there may be variations in the amount and distribution of the rainfall due to various causes. They might, for example, be due to variations from year to year in the strength of the south-east trades and their continuation the south-west monsoon currents in the Indian Seas. If the south-east trades were weak, but determined normally across the Equator, the monsoon currents in the Indian Seas and neighbouring land areas would be much feebler than usual, and there would hence be a general deficiency, varying in amount in different parts. There might also be a general deficiency due to an abnormal and prolonged set of the south-east trades to South Africa and hence to a smaller flow across the Equator from the south-east trades region than usual.

"On the other hand, the south-east trades and south-west monsoon currents might be of normal strength or stronger than usual, yet, as the result of conditions established during the preceding hot weather, the current might be determined

more largely than usual to a part of the area to the detriment of the remaining areas. There might hence be more unequal distribution of the monsoon rainfall than usual, although the average for the whole area might be normal or in excess.

" It is almost self-evident that the former cause (weakness of the south-east trades) would give rise to the largest and most general deficiency, whilst the latter (unequal distribution due to local conditions) would be far more frequent and would give rise to local deficiency and excess and hence to droughts of moderate extent and intensity."

7. As there seems to be some misconception as to the importance of the Himalayan snowfall and the extent of its influence on the monsoon currents and the distribution of the south-west monsoon rainfall in India, it appears to be desirable to state the theory in the form it has been employed by the Meteorological Department for many years. The theory was stated by the late Mr. Blanford in a paper entitled " On the connection of the Himalayan snowfall with dry winds and seasons of drought in India " read before the Royal Society in 1884.

The most important of the conclusions of this paper embodying the chief points of the theory are as follows :

1st.—The experience of recent years affords many instances of an unusually heavy and especially a late fall of snow on the North-Western Himalaya being followed by a prolonged period of drought on the plains of North-Western and Western India.

2nd.—The conclusion is that an unusual expanse of snow on the North-West Himalaya, whether due to the unmelted residue of an unusually copious winter snowfall or to an unusually late fall in the spring months, acts at high levels in the summer months, in somewhat the same way as the ordinary falls of snow and rain on the Lower Himalaya do at low levels in the winter season and favours the production of dry north-west winds on the plains of Western India.

3rd.—That this dependence of dry winds on the Himalayan snowfall affords a criterion for forecasting the probabilities of drought in North-Western and Western India.

The theory asserts that the distribution and character of the snowfall in the Western Himalayas is one factor (of several) determining the distribution of rainfall in the south-west monsoon. It states that excessive and late or untimely winter snowfall tends to give rise to conditions which divert the monsoon currents from North-Western India and hence give diminished and perhaps scanty rainfall and drought. It does not assert that scanty winter rainfall is necessarily followed by good south-west monsoon rains in Upper India, as they depend upon other factors, more especially the general strength of the monsoon current which is mainly determined by the strength and steadiness of the south-east trades air movement.

REPORTS OF SNOWFALL ON THE AFGHAN MOUNTAINS AND HIMALAYAS DURING THE WINTER OF 1900-01.

The whole of the information referring to the snowfall in the mountain districts bordering Northern India for each month of the year is now published as it is received in the India Monthly Weather Reviews.

8. The following gives a brief summary of the information relating to the snowfall of the past cold weather obtained up to date :

I.—AFGHAN MOUNTAIN DISTRICTS.

(1) HILLS WEST OF DERA ISMAIL KHAN, INCLUDING WAZIRISTAN.

(1) WANA.

November.—Light snow fell on the 15th on the Marwati, Kanigoram and Pirghal hills above 6,500 feet.

December.—Snow fell on the 2nd, 18th, 23rd, 24th, 25th, 30th and 31st. The fall on the 23rd and 24th averaged 2 feet on the higher hills. The storm of the 30th—31st was severe and gave heavy snow. The fall on Kundeghar was 5 feet in depth. Snow lay on the hills above 6,500 feet in height during the whole month.

January.—Snowstorms occurred in the district on the 1st, 4th, 10th and 12th. The falls on the 1st, 4th and 10th were light, but that of the 12th was moderately heavy, ranging between 2 and 3 feet in depth on the Kanigoram, Marwati and Pirghal ranges. Snow fell as low down as Wana (elevation about 3,000 feet).

February.—Snow fell on the 4th, 6th, 7th, 13th, 14th, 17th and 19th. The falls of the 4th, 13th, 14th, 17th and 19th were light to moderate in amount and of the 6th and 7th were heavy. The depth of the fall at Marwati was 4½ feet and on the Pirghal 4 feet. At the end of the month the snow accumulation on the Pirghal, Marwati and Kanigoram ranged between 2 and 3 feet.

March.—No snow fell in this area during the month. The snowfalls of the past winter were much heavier and more frequent than for some years previously.

(2) Dera Ismail Khan (Kulachi Border).

December.—Snow fell on the 19th, 20th and the 23rd to the 31st on the hill ranges to the west of this district.

January to April.—No reports received. Hence probably no snow fell on these hill ranges.

(3) Kurram.

The following is a summary of the reports received from the Civil Surgeon, Kurram:

September.—Snow fell on the Sufed Koh down to 16,000 feet on the 23rd, 26th and 27th.

October.—Snow fell on ten days on the Sufed Koh down to about 10,000 feet.

November.—Snow fell on ten days down to 9,000 feet in the first-half of the month and to 7,000 to 6,500 feet in the second-half.

December.—Snow fell on fifteen days during the month. During the storms of the 22nd to the 26th and the 29th and 30th it fell as low as 4,500 feet. All passes across the Sufed Koh were closed during the month.

January.—Snow fell on ten occasions and on seven days as low as Parachinar (5,200 feet) and on one occasion as low as Sadda (4,000 feet above the sea-level). At Parachinar 2¼ feet were received on the 11th and 12th. The accumulation on the passes at the end of the month was estimated at 10 feet.

February.—Snowstorms occurred on twelve days of the month, on six days of which it fell as low as Parachinar (5,200 feet). A peculiarity of the storms was that they came from the south and fell in the valley several miles below Parachinar as low down as 4,000 feet. The passes were all closed during the month.

March.—Snow fell on eleven days above 8,000 feet on the Sufed Koh.

April.—Snow fell on five days during the month on the Sufed Koh.

The snowfall of the past winter is stated to be heavier than has been received for many years past. The weather was more cloudy than usual and very cold in the early part of the winter.

(4) Kohat District (Tirah).

January.—During the month there were in all eight falls of snow on the hills on the border, *viz.*, on the 7th, 10th, 11th, 13th, 18th, 19th, 21st and 31st. The total fall at Fort Lockhart, which is the only place from which accurate and reliable reports can be obtained, was 3¼ feet.

On the 13th and 21st heavy falls were reported from the Samilzar Iláqá Astar Ghar (5,411 feet high). On the same dates falls estimated at 3 and 3½ feet respectively were reported on the Maula Ghar, Lundakar and Mazza peaks (elevation between 7,000 and 8,000 feet) across the border—the first mentioned to the north of the Astar Ghar and the two latter to the west of it.

February.—Nine falls of snow were reported on the hills on the border. The heaviest fall occurred on the 5th on the hills in the Samilzar Iláqá. The total fall of the month at Fort Lockhart was 2 feet 2 inches.

The Commandant, Border Military Police, adds with respect to my request for information from the inhabitants of the district as to the character of the snowfall of the present year as compared with that of previous years: "This is generally very misleading, for the inhabitants have two stereotyped replies; it is either severe drought or too much rain and snow. This year the Orakzais state that they have never had so much snow and they made the same remark last year."

The following report of the snowfall on the Samana range (to the west of the Kohat district) has been submitted by the Assistant Commissioner, Thal:

December.—Snow began to fall on the 23rd on the Samana range. Light falls occurred on the 23rd, 24th, 25th and 30th.

January.—Light falls of snow occurred on the 10th, 11th and 12th. Snow also fell on the Samana range on the 13th January on the lower heights in the neighbourhood of Sháhu Knel, Chappar and Ibrahimzar to a depth of from 1½ to 3 inches. Roughly speaking, the snowfall on the last mentioned heights which reach an altitude varying between 2 000 and 3,000 feet above sea-level may be taken to represent the lowest limit to which snow descended.

As a general rule, snow in the hills was accompanied by rain in the plains, and it is to be noticed that as the latter increased in intensity the snow owing to the cooling of the atmosphere descended to a lower limit. Thus the lowest limit recorded was not observed until the 23rd January when snow had been received on the higher slopes of the Samana more or less intermittently for three weeks. The weather in the intervals between the snowstorms was fine and bright, though probably not colder than usual. With the exception of the higher slopes of the Samana, *i.e*, Fort Lockhart, Saragarhi and the Samana Sukh, the snow melted as soon as it fell, and even on the southern slopes of the latter the action of the sun was sufficient to cause the snow to disappear until a further fall. The same remarks apply to the hills to the north of Danzab, Torwari, Darsamand and Thal.

The results therefore to be deduced from the observation of the snowfall for the last month are:

(1) Its local nature.

(2) A varying snow-line according as the intervals between successive snowfalls were short or long.

(3) Rapid disappearance of the snow except on the higher northern slopes where the sun's rays were not sufficiently powerful to cause it to melt.

The temperature of the month was normal.

The winter of the year 1900 was marked by unusual severity. 2 inches of snow fell in Hangu itself (about 2,000 feet in elevation)—an almost unprecedented occurrence.

February.—Snow fell on the 4th, 5th, 7th, 14th and 17th over the Samana range. The total fall was estimated at 2⅙ feet. The weather was milder than usual.

March.—No snow fell on the Samana range in this month. The snow melted away before the end of the month.

April.—No snow fell during this month

(5) KABUL.

The following is a summary of the information received from the Meteorological Observer, Kabul, through the British Agent :

November.—Light snow fell at Kabul on the 20th and 22nd. The Paghman hills were covered with snow at the end of the month.

December.—Snow fell at Kabul on nine days during the month, *viz*, the 16th to 18th, 22nd to 24th, 26th, 29th and 30th.

January.—Snowfalls occurred on the 9th to the 12th, the 18th, 22rd and 31st in Kabul city. Frequent falls were received on the Paghman range and the passes on the roads from Kabul to Ghazni and Gandamak were closed during the month. The Kabul plain was covered with snow during the month.

February.—Storms gave moderate to light snow on the 5th, 6th and 18th. The snow accumulation in the Kabul valley melted away during the month.

March.—Snow fell on the 6th. The Paghman hills were covered with snow at the end of the month.

(6) KHYBER.

The Political Officer, Khyber Pass, has forwarded the following account of the snowfall in the neighbouring ranges :

"No snow fell in this district before the 27th December. Heavy rain fell at Landi Kotal and its vicinity and continued at intervals from the 27th December to the 3rd January. Snow fell on the high peaks of Lakka, Dalkhud, Torsappar, etc., the average depth being one foot.

"It again began raining on the 10th January and continued till the 13th. Heavy snow fell on the 14th and 15th over the neighbouring hills and plains. The average depth of snow on the hills was 12 inches, while on the Loargi plateau it was 6 inches. Snow again fell on the 5th February, the depth on the high peaks being 1½ feet. In the plains the snow melted as soon as it fell.

"Unusually stormy and cold winds blew in the intervals between the storms. The snowfall in the area is believed to have been about normal in amount."

(7) CHITRAL.

October.—Slight snow fell on the neighbouring mountain ranges above 10,000 feet on the 4th and 24th.

November.—Heavy snow was received on the 17th, 22nd and 23rd on the neighbouring ranges.

December.—Snowstorms occurred on the 2nd, 12th, 15th to the 18th and 22nd and 23rd. The falls of the 12th, 15th, 22nd and 23rd were heavy on the neighbouring mountains and moderate at Drosh.

January.—Snow fell on eight days in this month, *viz.*, the 7th, 10th to the 13th, 20th, 21st and 26th. The fall of the 12th and 13th was heavy on the neighbouring mountain ranges. Light snow fell at Drosh (4,000 feet).

February.—Storms giving light snow to the higher mountain ranges occurred on the 4th, 6th and 16th to 18th. The fall extended to Drosh on two occasions.

March.—Light snow fell on the highest ranges on the 5th, 6th and 21st.

April.—Heavy snow fell on the mountain ranges to the north of Drosh and Chitral on the 13th and 14th.

May.—Heavy snow fell in the Chitral district down to 6,000 feet in the Chitral valley and hills on the 5th and 6th.

The following gives comparative data of the precipitation at the observatories of Chitral and Drosh for the period November to April :

Chitral.

Year.	Rainfall.						
	November.	December.	January.	February.	March.	April.	Total fall, November to April.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
1896-97	0	0·02	4·88	2·94	4·65	4·20	16·69
1897-98	0	1·68	0·63	1·65	15·25	6 28	25·49
1898-99	0·05	1·55	0·10	2·28	3·11	2·10	9·14
1899-1900	2·25	1·74	2·60	0·80	2·49	1·61	11·49
1900-1901	0	0	0	0	4·09	4·22	8·31

Killa Drosh.

1897-98	0	1·98	1·45	1·26	2·12	5·34	22·15
1898-99	0	1·16	0	2·19	2·27	2·66	8·28
1899-1900	0·80	1·49	?	1·35	2·61	2·44	8·69
1900-1901	0 94	1·47	0	0·49	4·37	3·67	10·94

II.—HIMALAYAS.

(A) THE PUNJAB AND KASHMIR HIMALAYAS.

(1) MURREE.

9. The following tables give statements of the snowfall as measured at Murree and on the hills near Kahuta during the past and preceding winters for comparison :

Station.	Total fall of snow in the month of					Total of period 1900-1901.
	December 1900.	January 1901.	February 1901.	March 1901.	April 1901.	
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Murree . .	1 8	7 11	4 9	0 6	*Nil*	14 10
Kahuta . .	?	4 0	*Nil*	*Nil*	*Nil*	(?) 4 0

Station.	Total fall of snow from January to March in												Average of twelve years.
	1901.	1900.	1899.	1898.	1897.	1896.	1895.	1894.	1893.	1892.	1891.	1890.	
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Murree	13 2	12 2	6 7	6 8½	10 2½	7 5	11 10	15 9	29 4	0 5	29 0	3 8	12 2
Kahuta	4 0	5 0	7 0	13 2	4 0	1 0	6 0	5 0	18 0	*Nil*	5 3	0 9	5 9

The data show that the snowfall at Murree and Kahuta was practically normal and was comparable in amount with the falls in the cold weathers of 1895, 1897 and 1900.

(2) KASHMIR.

The following account of the snowfall in Kashmir during the past winter has been received from Dr. Mitra, Meteorological Reporter, Kashmir State:

"The last winter in Kashmir has been normal in character. Snow began to fall somewhat earlier than usual and the higher ranges had their first fall of snow on the 4th October and the last on the 21st April 1901, descending as low down as 6,500 feet.

The first fall of sleet in Srinagar was on the 17th December and of snow on the 19th December."

The following table gives the total snowfall up to the 21st of February as measured in Srinagar (in inches of rain):

December.	Amount of snowfall measured as water.	January.	Amount of snowfall measured as water.	February.	Amount of snowfall measured as water.
	Inches.		Inches.		Inches.
19th	0·39	1st	0·05	1st	0·25
24th	0·58	9th	0·07	2nd	0·04
26th	0·18	14th	0·97	6th	0·70
27th	0·21	15th	0·32	7th	0·14
		16th	0·08	13th	0·05
		22nd	0·34	14th	0·09
				17th	0·57
				18th	0·17
				19th	0·07
				20th	0·06
				21st	0·05
Total	1·36		1·83		2·19

The periods of heaviest snowfall were from the 19th to the 27th December, the 14th to the 22nd January and the 17th to the 21st February.

Some avalanche accidents were reported from the higher passes of Burzil on the way to Gilgit and Zoji-La pass *en route* Leh. Two mail carriers were buried in the avalanche at the former pass and two coolies under the latter.

The following table shows the snowfall measured as rain during the winter under review and the previous five winters for comparison:

Year.	Precipitation.						Total.
	December.	January.	February.	March.	April.	May.	
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
1900-1901	1·36	1·83	2·19	0	0	0	5·38
1899-1900	0	3·38	1·80	0	1·95	0	7·13
1898-99	2·73	0·68	4·21	2·01	3·44	1·38	14·45
1897-98	0·35	1·91	2·15	0·76	1·28	2·64	9·09
1896-97	0·63	6·18	1·38	5·79	4·93	4·53	23·44
1895-96	0·62	1·09	2·46	2·22	1·48	2·22	10·09

The comparison indicates clearly that the snowfall at Srinagar during the past winter was less than the normal and largely below the falls of the winters of 1896-97 and 1898-99.

The rainfall for the month of April was four inches less than that of April 1900.

(3) LADAKH.

Full accounts of the snowfall during the past winter in Ladakh have been received from the Superintendent of the Leh observatory. The following is a brief summary of these reports:

October.—Frequent light showers of snow were received on the hills surrounding Leh down to an elevation of 13,500 feet. Light snow showers fell on two occasions at Leh. The snow-line was at a height of about 14,000 feet at the end of the month.

November.—No snow fell at Leh.

December.—Light showers of snow fell at Leh on the 19th and 27th. Frequent snowstorms occurred on the surrounding hills, giving snow down to 13,000 feet. The weather was unusually damp and cloudy.

January.—Light snow showers fell in Leh and the neighbourhood on fourteen days during the month. The weather was unusually unsettled and cloudy.

February.—Snowstorms occurred on eight occasions during the month. The falls were light in the Indus valley. About six inches of snow were lying in the open near Leh at the end of the month.

March.—Light snow fell on the 3rd, the 24th and 25th.

April.—Frequent snow showers fell on the neighbouring hills. Weather during the month was unusually cloudy, cold and damp.

(4) LAHOUL.

The following gives a statement of the snowfall registered at the observatory at Kailang in Lahoul during the past winter and also the mean of the corresponding periods of the past five years for comparison:

Month.	Normal monthly precipitation measured as rainfall. (Derived, from 25 years data.)	RAINFALL, 1901. Total precipitation of month measured as rainfall.	SNOWFALL, 1901. Total snowfall of month.	Mean snowfall in month of past five years.
	Inches.	Inches.	Ft. In.	Ft. In.
November . . .	0·61	0·01	*Nil*	0 8
December . . .	1·01	3·54	2 9½	1 11
January . . .	3·07	2·71	1 10	2 3
February . . .	3·20	4·63	3 8	2 4
March . . .	3·39	1·61	*Nil*	2 10
April . . .	2·80	Return not received.	Return not received.	1 4
Total .	14·08			11 4

The snowfall at Kailang during the period November to March was hence about normal.

It was similar in amount to that of the corresponding period of 1899-1900.

The Superintendent of the observatory writes as follows :

"In our narrow valley at Kailang snowstorms are not of frequent occurrence. The past winter has been an exceedingly cold one. During December, January and part of February the temperature was mostly about zero. Even in the day time it was very cold, as the skies were usually thickly clouded. Fine weather with sunshine was very scarce this season.

At Kailang (10,000 feet) the snow was about 6 feet deep about the middle of March. Altogether we have had about 10 feet snow. In the valley men can go from one village to the other now, but only in the morning when the snow is frozen. The passes were all closed from 13th December to the date of the report (11th March).

Really less snow than the normal has fallen, but in the absence of sunshine it has not yet begun to melt."

(5) Simla Hill Districts.

The following is a summary of the data for these districts received from the Deputy Conservator of Forests, Bushahr Division :

October.—Snow fell on eight days during the month down to 9,000 feet. The depth of snow on the 31st October on the Borenda and Shatul passes was 2½ feet. The Rupin, Runang and Bulder passes were free from snow.

November.—Light snow fell on the 21st and 25th down to 10,000 feet. The depth of snow at the end of the month on the Rupin pass was 5½ feet, on the Borenda pass 6 feet, on the Shatul pass 6 feet and on the Bulder pass 8 feet. All these passes were how closed for the season.

December.—Snow fell on ten days during the month. The falls were unusually light. The depth of snow on the passes at the end of the month was estimated at from 15 to 20 feet.

January.—Light to moderate snowfalls were received over the whole area above 5,750 feet on eight days during the month and frequent falls occurred on the higher ranges. The month was unusually cold and cloudy. The depth of snow at the end of the month on the higher passes is not known, but is said to range from 20 to 50 feet. All passes were closed during the month. The fall during the month was much heavier than has occurred for several years past.

February.—Light to moderate falls of snow occurred on the 5th, 13th, 14th, 18th, 20th, 22nd and 23rd down to 5,700 feet. Slight falls were also received on the 2nd, 4th, 6th to 8th, 12th and 19th at higher hills. The depth of snow at the end of the month on the Borenda, Rupin and Shatul passes was estimated to be 28 to 30 feet and on the Bulder pass 31 feet. The snowfall was much heavier than in the same month last year.

March.—There were light falls on the 7th, 8th and 24th. These falls were general throughout the whole of Bushahr. All the passes over 10,000 feet in elevation were closed throughout the month. The depth of snow at the end of the month on the Rupin and Borenda passes was 29 feet, on the Shatul pass 32 feet and the Bulder pass 33 feet.

April.—There were several falls of snow during the month, *viz.*, on the 11th, 12th, 14th and the 20th to the 23rd. The snow-line descended to about 8,500 feet on the 22nd and 23rd. The accumulation at the end of the month measured 14 feet on the Bulder pass (16,000 feet high), 12 feet in depth on the Rupin and Borenda passes (each 16,000 feet high), 6 feet on the Runang pass (14,000 feet high) and 1½ feet on the Harang pass (12,000 feet). All these passes except the Harang pass were closed at the end of the month.

The snowfall was larger and the winter has been longer than for several years past.

The Superintendent of the observatory at Poo in the Upper Sutlej Valley writes that "the winter snowfall commenced earlier than usual on the 23rd of December. Although the amount of snow accumulation probably does not exceed that of the previous year, it is lying longer on account of the cloud being greater than during the corresponding period of 1899-1900."

(6) CHAMBA.

December.—Snowstorms occurred on thirteen days of the month. The most severe storms were those of the 24th and 31st. The snow fell down to 2,500 feet on the 24th. Five feet of snow fell at Kalatop on the 31st. There was 8 feet of snow lying at Kalatop at the end of the month. The snowfall commenced earlier than usual on the higher elevations.

January.—Snow fell on fifteen days of the month. The falls were most general between the 12th and 23rd. The depth of the snow accumulation at the end of the month was 8 feet at Kalatop (7,500 feet) and 4 feet at Barmaur (5,000 feet).

February.—Frequent light falls of snow occurred during the month. Measurable amounts were recorded on 22 days of the month. The skies were clouded to an unusual extent. The snow accumulation at the end of the month was 7⅛ feet at Kalatop and 5 feet at Barmaur and Olansa.

March.—Very light falls were reported on the 6th and 7th. The depth of snow on Kalatop at the end of the month was reduced to 2½ feet.

The snowfall in this district during the past year was greater than in the preceding winter. There appears from all the information received to have been exceptionally heavy snow on the higher elevations above 6,500 feet. Below that there was much rain, but little or no snow.

The following statement gives the snowfall as measured at certain forest stations during the past winter in the Chamba State:

Month.	Pangi.	Dalhousie neighbourhood.		West of State	Tisa range, north of State.				Valley of Ravi.			
	Killar, 8,400 feet.	Kalatop, 8,000 feet.	Surkhigalli, 5,000 feet.	Bhandal, 6,000 feet.	Tisa, 5,000 feet.	Thanela, 7,500 feet.	Chanan, 6,500 feet.	Alwas.	Dareri, 4,500 feet.	Chitrari, 6,000 feet.	Olansa, 7,000 feet.	Barmaur, 8,600 feet.
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
November 1900	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*			*Nil*	*Nil*	*Nil*	*Nil*	*Nil*
December ,,	5 4	10 3	1 ¾	1 9½	1 3			5 7½	0 7	2 7	6 3	7 11
January 1901	4 5	5 9	3 8	3 8½	3 4			8 5	2 4	3 1	7 7	8 8
February ,,	4 0	7 0	1 4	3 10	1 2			12 5	1 3	4 3	9 6	9 4
March ,,	1 7	0 11½	0 1½	0 2	*Nil*			0 7	*Nil*	*Nil*	0 10	1 6
April ,,	0 11				Data	not	yet	received				
Total to March or April	16 3	23 11½	6 2	8 5½	5 9			27 0½	4 1	9 11	24 2	27 0
Mean, November to April, five years.	...	12 0	2 4	4 5	8 1	11 2	6 8	...	?	8 0	15 11	25 0

The following report of the snowfall in Pangi has been received from the Deputy Conservator of Forests:

December.—Snow fell on ten days during the month on Killar (8,400 feet high) down to 6,400 feet. The total fall of the month measured about five feet in depth.

January.—Frequent light falls of snow occurred at Killar during the month. The snow-line was at 6,400 feet throughout the month.

February.—There were five periods of disturbed weather and snowfall during the month, *viz*, the 2nd and 3rd, 5th and 6th, 12th, 16th to 19th and 21st. The total fall of the month was estimated to be 4 feet.

March.—Snow fell on the 6th, 21st and 23rd. The falls were light and the total of the month was only 1½ feet.

April.—There were light falls of snow on the 10th, 11th, 19th, 20th, 21st and 22nd. The snowfall extended down to 6,400 feet on the 20th to 22nd.

Weather was more windy than usual during the period December to April.

There was no snow lying at Killar on the 5th of May. The Sach pass was still closed.

The snowfall began earlier than usual in the beginning of December and was above the average on the higher hills.

(7) KULU.

The following is a summary of the reports received from the Assistant Commissioner, Kulu :

January.—Snow fell on nine days during the month on the high ranges of the Kulu Tahsil and on eight days in the Plach Tahsil. The falls were general and descended to 5,200 feet.

February.—Snowstorms occurred on five days in the Kulu Tahsil and thirteen days in the Plach Tahsil. The falls were general and occurred above an elevation of 5,000 feet. The snowfall of the month was above the normal.

March.—There was slight snowfall on four days of the month on the higher peaks and passes. The snowfall of the month was in slight excess.

April.—Rain fell slightly on the 10th, 11th, 13th and 14th in the Kulu Tahsil and on the 11th, 12th, 14th and 15th in the Plach Tahsil. During this period snow fell on three occasions on the higher passes and peaks down to about 10,000 feet.

The Rotang pass was closed for seven or eight days due to this snowfall.

Nearly all the passes in this district were open for foot traffic at the end of the month.

The snowfall of the month exceeded in amount that of the corresponding period of the previous year in the Plach Tahsil, but was in defect in the Kulu Tahsil.

The following table gives the depth of snow at the end of each month from January to April 1901 and also on the 25th April of the past ten years on seven of the passes in this district for comparison :

Tahsil.	Name of pass.	Elevation.	Depth of snow in				Mean, April past 9–10 years.	Depth of snow on the 25th April								
			January 1901.	February 1901.	March 1901.	April 1901.		1900.	1899.	1898.	1897	1896.	1895	1894	1893.	1892.	1891.
		Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet	Feet.	Feet.	Feet.	Feet.
Kulu	Hamta .	14,500	10	11	7	2	6½	6	3	0	11	9	4	10	11	2½	?
	Rotang .	13,000	12	16	13	6	11⅓	28	7	3	11	16	13	13	13	3	10
	Bhubhu .	10,000	12	11	6	4	2½	2	2	0	2	½	3	2	5	?	5
Plach	Gargarasan	17,000	14	17	10	6	8	4	3	2	7	1	10	8	25	?	12
	Srikand .	15,000	18	25	18	10	14⅔	11	6	6	15	8	15	15	30	6	36
	Basleo .	11,000	11	14	8	4	3½	2	1	0	3	0	4	3	15	?	4
	Jalo.i .	10,500	10	14	8	4	2½	2	1	0	3	0	4	4	6	?	4

(B) NORTH-WESTERN PROVINCES HIMALAYAS.

(1) KUMAON.

10. The following is a statement of the estimated snowfall in this district measured in the same manner as in former years in accordance with arrangements made in the year 1894 :

Month.	Fall on Pindari and Pankua peaks.		Fall on Ralum-dhura and Utam-dhura passes.		Fall on Malla Byans, Chandan and Darma.	
	Ft.	In.	Ft.	In.	Ft.	In.
1st to 31st October 1900	3	0	11	0	3	0
1st to 30th November 1900	*Nil*		*Nil*		*Nil*	
1st to 31st December 1900	7	0	16	0	4	6
1st to 31st January 1901	8	0	16	0	10	6
1st to 28th February 1901	4	6	18	0	7	0
1st to 31st March 1901	1	9	10	0	6	0
1st to 30th April 1901	0	2½	6	0	2	0
Total fall in winter of 1901 up to 30th April	24	5½	77	0	33	0
Mean of six cold weathers, October to April	25	7	63	11	18	11

The snowfall of the past winter in Kumaon was considered by the natives of the district to be more than usual during the greater part of the season. The data of the preceding table show that it was on the average of the whole area greater than usual for the whole period. The fall was similar in amount to that of the winter of 1899-1900.

(2) GARHWAL.

The following is a summary of the reports received from the Deputy Commissioner, Garhwal:

October.—Snow fell on the 13th, 16th, 19th, 22nd, 26th and 28th on the perpetual snows down to about 12,000 feet. The depth of the fall was estimated to be from 6 inches to 3½ feet.

November.—No snow fell during the month in this area.

December.—Snow fell at frequent intervals during the second-half of the month. The falls were heaviest on the 19th, 24th and 31st when the snow-line descended to about 6,500 feet.

January.—There were frequent falls during the month and the snow-line descended to about 5,000 feet. The passes into Thibet were all closed.

February.—Snow fell more or less intermittently throughout the month. The more considerable falls were on the 18th, 19th, 22nd and 23rd. The snow-line descended to about 5,000 feet.

The snowfalls were more frequent than usual at this time.

March.—Snow fell in the region of the perpetual snows on the 1st, 6th, 7th, 15th, 21st and 22nd. The Mana and Nite passes leading into Thibet were open before the end of the month. The snowfall of the whole winter was larger in amount than the normal.

April.—Light falls of snow occurred in the region of perpetual snows on the 14th and 15th. The total fall of the month was less than that of the corresponding period of the previous year.

(C) ASSAM HIMALAYAS.

11. *Hills north of Lakhimpur.*—The Sub-divisional Officer, North Lakhimpur, reports that "the snowfall during the past season in the hills north of is understood to have been below the normal. There has certainly been less snow than usual on the peaks visible from the plains."

Hills north and east of Sadiya.—The Assistant Political Officer, Sadiya, reports as follows:

"Small snowstorms occurred early in the season, but the heavy snows came down later than usual, and judging from the mildness of the last winter, I do not think the fall was as great as it was last year.

The rivers are all abnormally low for the time of year, though the weather has been quite warm enough of late to melt the snows, and this confirms my belief that the fall of snow has been smaller than usual during the last winter."

Hills north of Darrang District.—The Deputy Commissioner states that no reliable information is available and adds that "the Bhutia Chiefs who came down to Mangaldai reported that the snowfall this year was heavier in the hills than in the last year. This has been corroborated by the Charduan Bhutias and the Akas who came to Tezpur and reported that the snowfall in their hills was very heavy."

Hills north of Kamrup.—The Deputy Commissioner, Kamrup, reports as follows: "Snowstorms occurred at intervals during November, December and January. The snowfall was heavier, the depth being reported to be varying from 28 inches to 30 inches in different peak ranges and passes.

"The snow line is reported to have descended on the peak known by the name of Youngla hill, the height of which is not known, extending to the Salikhora road.

"Snowstorms occurred over an extensive area, though the exact length and breadth have not been given. The weather during the storm was cloudy, but its general character during the intervals was unusually cold.

"It is reported that there was no snow accumulation for some time previous to this date (31st March) on any of the roads leading to the hills; but as there was a heavier fall during the year, it is likely that there is still an accumulation of snow at this date on the hills.

The snowfall is reported to have been greater than in the previous year."

Hills north of Upper Burma.—Mr. Wright, Manager of the Choukpazat Gold Mining Company, Mu Valley, Upper Burma, writes as follows:

"The winds from the north have not been out of the way cold, and I think therefore that there could not have been an unusual fall of snow. I am inclined to think the fall has been probably less than usual."

The Deputy Commissioner, Myitkyina, in a letter to Mr. Wright, states that "I am afraid I cannot give you information of any value this year as to the weather in northern unadministered tracts, as we have had no column up there this year.

"There is, however, no reason to believe that the weather has been abnormal, or that there has been any heavy snowfall. The cold season here was warmer than usual, but this I attribute to scanty rainfall in 1900 and early drying up of vegetation. But March, April and so far May have been unusually temperate though we have had less rain during these months than usual. In March the thermometer only once touched 90°, in April the maximum was above 90° on three days only (90·5°, 92·0°, 91·0°) and the maximum up to date in May has been 95·5°. This seems cool for a place at 450 feet elevation only. The prevailing winds this year have been north instead of west as they usually are.

"There was a rise in the river from 14th to 20th April, but this was too high and sudden to be due to melting of snow.

"There must have been a heavy fall of rain near the head waters of the Ninai kha river."

PERSIA.

12. The data for this area are scanty. The winter commenced earlier than usual in Persia and Baluchistan, and the precipitation was generally above the normal in these areas in the months of November and December.

During the remainder of the season the weather was much drier than usual in Persia, and the precipitation of the whole cold weather period was hence largely in defect. The returns from the stations of Dasht Arjin, Sivand, etc., on the Indo-European Telegraph line show that frequent snow occurred on the higher

elevations in December and occasional snow in January, after which dry weather set in and held steadily during the remainder of the winter.

The following table gives comparative data of the precipitation at several stations in the Persian area and also at Quetta and Kashgar :—

Station.	RAINFALL.												RAINFALL OF PERIOD NOVEMBER 1900 TO DATE OF LAST RETURN.		
	November 1900.		*December 1900.*		*January 1901.*		*February 1901.*		*March 1901.*		*April 1901.*				
	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Percentage variation from normal.
	Inches	Inches	Inches	Inches	Inches	Inches	Inch	Inches	Inches	Inches	Inch	Inches	Inches	Inches	
Baghdad	1·69	+ 0·66	1·40	− 0·55	0·53	−1·06	0	− 2·49	0·28	− 1·65	...	...	3·90	−5·09	−57
Teheran	2·61	+ 1·57	1·05	− 0 26	0·41	−0·75	...	...	...	...	...	...	4·07	+ 0·55	+ 10
Ispahan	0·35	−0·81	0·05	−0·40	0	−0·11	0	− 0·04	...	...	...	...	0 40	−1·36	−77
Bushire	1·92	−0·68	3·82	+ 0·71	1·22	− 2·01	0	− 1·23	1·09	−0·34	0·27	− 0·07	8·32	−3·62	−30
Jask	0·82	+ 0·38	2·90	+ 2·42	0·60	−0·40	0	−1·09	0	−1·21	0	− 0·04	4·32	+ 0·06	+ 1
Quetta	1·67	+ 1·40	4·24	+ 3·51	3·12	+ 0·01	0·07	−2·14	1·15	− 0·55	0·19	−1·01	9·44	+ 1·22	+ 15
Meshed	0·92	+ 0·41	0·70	+ 0·32	0·01	−0·22	0	−0·90	0·31	−1·89	...	...	1·94	− 2·28	−54
Kashgar	0	−0·04	0	−0·27	0·11	−0·31	0·01	+ 0·01	...	...	...	...	0·12	−0·61	−84

PRECIPITATION ON THE OUTER RANGES OF THE HIMALAYAS.

13. The precipitation of the period on the outer ranges of the whole Himalayan area is indicated very clearly by the data of the following table:

Station.	PRECIPITATION.												PRECIPITATION OF PERIOD NOVEMBER 1900 TO APRIL 1901		
	November 1900.		*December 1900.*		*January 1901.*		*February 1901.*		*March 1901.*		*April 1901.*				
	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Actual.	Variation from normal.	Percentage variation from normal.
	Inch	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	
Srinagar	0	−0·25	2·48	+ 1·64	2·51	−0·08	3·05	+ 0·11	2·76	+ 0·26	4·36	+ 3·21	15·16	+ 4·89	+ 48
Leh	0	−0·03	0·16	0	0·94	+ 0·61	0·22	−0·06	0·05	−0·18	0·15	+ 0·04	1·52	+ 0·38	+ 33
Kailang	0·01	−0·43	3·54	+ 1·79	2·71	−0·12	4·63	+ 3·13	1·61	−1·78	1·55	−1·25	14·05	+ 1·34	+ 11
Cherat	0·06	−0·18	3·04	+ 2·32	6·01	+ 3·07	2·61	+ 0·27	4·25	−0·68	1·44	−0·86	17·41	+ 3·94	+ 29
Murree	0·24	−0·84	2·67	+ 1·47	6·01	+ 2·49	1·71	−2·02	4·53	+ 0·88	4·60	+ 1·20	19·76	+ 3·18	+ 19
Simla	0	−0·54	3·59	+ 2·85	6·20	+ 3·85	9·04	+ 6·36	4·76	+ 2·52	0·09	−1·81	23·68	+13·23	+ 127
Kotgarh	0	−0·63	4·67	+ 4·06	2·50	+ 0·32	2·50	−0·26	5·70	+ 1·01	...	...	...	...	...
Kiiba	0	−1·97	4·97	+ 3·73	5·36	−0·25	6·60	+ 1·30	2·18	−3·82	...	...	...	...	...
Chakrata	0	−0·59	5·55	+ 4·89	10·36	+ 6·83	6·67	+ 2·86	2·20	−0·19	0·10	−1·38	24·88	+12·42	+ 100
Mussooree	0	−0·40	5·18	+ 4·12	8·66	+ 5·83	4·89	+ 2·00	2·00	−0·58	0·50	−0·92	21·23	+10·05	+ 90
Ranikhet	0	−0·33	2·08	+ 1·55	4·03	+ 1·09	3·40	+ 1·45	2 10	−0·14	0·12	−0·99	11·73	+ 2·63	+ 29
Katmandu	0	−0·18	0·62	+ 0·37	2·32	+ 1·52	0·52	−0·56	1·69	+ 0·46	0·80	−1·29	5·95	+ 0·32	+ 6
Darjeeling	0	−0·20	0·34	+ 0·12	1·63	+ 0·96	0·06	−0·89	2·34	+ 0·69	1·53	−3·08	5·90	−2·40	− 29
Guntak	0·51	−0·92	0·31	−0·23	2·03	+ 1·34	0·10	−2·19	6·28	+ 1·23	11·06	+ 0·73	20·29	−0·04	0
Yatung	0	−0·34	0·58	+ 0·52	3·00	+ 2·69	0·43	+ 0·05	3·58	+ 0·46	5·11	+ 0·15	12·70	+ 3·53	+ 38

The data indicate that the precipitation was in large excess in December and January and was generally in defect in March and April. The chief feature of the precipitation of the whole period was the very large excess at the stations of Simla, Chakrata and Mussooree (and perhaps Kotgarh). The lower and middle ranges of the Simla and Mussooree hills in fact received about double their normal fall. This excess was apparently a local factor, as it did not extend to the interior as indicated by the data of Poo, Kilba and Kailang. The precipitation at Murree, Srinagar and Leh, representative of the Kashmir hills, and at Ranikhet was only in moderate excess while in Sikkim it was below the normal. The distribution as indicated by the returns of these stations is in full agreement with that indicated in the corresponding higher regions by the snowfall reports.

SUMMARY OF THE SNOWFALL DATA.

14. The whole of the available data bearing on the character and amount of the snowfall in the mountain regions to the north and north-west of India has been given above. The data have been given in full detail, as the conclusions are partially opposed to statements that have appeared in various quarters with respect to the snowfall of the past winter. The data are consistent and indicate clearly the character and distribution of the snowfall of the past six months in the Himalayan area.

15. The accumulation at the commencement of the winter was unusually small. The snowfall during the previous winter at least had been less than the normal, and the accumulation in May 1900 was abnormally small on the higher ranges in Afghanistan and Chitral and about normal in the Kashmir and Punjab Himalayas. The snow-line was also somewhat higher than usual in May. In consequence of the prolonged delay in the establishment of the monsoon rains in Upper India the snow accumulation melted to a much greater extent than usual in June and July, and its amount at the beginning of October 1900 was much below the normal. October was more disturbed than usual in the hills of Upper India, but the light snow which fell at short intervals below the permanent snow-line melted almost immediately after its fall. November, on the other hand, was an exceedingly dry month in the Upper India hill districts and the snow-line at the beginning of the month of December on the ranges to the north of Simla was at an elevation of about 11,000 feet.

The number of cold-weather storms was greater than usual in January and February. Most of the storms were, however, of slight intensity and advanced along more southerly tracks than usual and hence failed to give rise to well-marked secondary depressions in the Punjab. Two storms, those of the 10th to the 15th January and the 4th to the 8th February, were moderately deep depressions and occasioned heavy snowfall in the Western Himalayas. The snowfall up to the end of February was in moderate to considerable excess in that area.

March was drier than usual and the snow accumulation at the end of that month was probably about the normal. It, however, melted more slowly than usual, as there was much more cloud than usual in the hill districts of Upper India. Weather was, on the other hand, unusually disturbed in April and the first fortnight of May. A heavy fall of snow down to unusually low levels (5,000 feet) in Kashmir and Chitral and the mountain areas to the north occurred on the 13th and 14th April and another heavy fall occurred in the same area in the first week of May. The chief result of this late snowfall is to give an accumulation probably exceeding the normal to a slight or moderate extent at the end of May in Kashmir and Chitral and the areas to the north.

16. The chief features of the snowfall of the cold weather were:

(1) The winter commenced in November and hence earlier than usual in Afghanistan and Baluchistan. Weather was fine and free from winter storms in the first-half of December. The latter half of December and January were more stormy than usual, and these areas received frequent rain and snow during this period. March, April, and May were, on the other hand, drier than usual. The snowfall of the period hence melted rapidly in these months and the accumulation disappeared except on the highest ranges of Afghanistan.

(2) The number of cold-weather disturbances in Upper India in November and the first-half of December was less than usual and the storms were of very slight intensity. A large number of storms formed in the second-half of December and in January. They advanced along more southerly tracks than usual and failed in the great majority of cases to give rise to well-marked secondary depressions in the Punjab. The precipitation accompanying them was hence generally moderate in amount. The snowfall up to the end of January in that area was probably somewhat greater than usual, but was nowhere excessive.

(3) The number of depressions in February, April and May was larger than usual. In consequence of their origin in North-Western India or Baluchistan, they chiefly affected the Punjab and Gangetic Plain. The Punjab hills, Kashmir and Chitral had frequent light to moderate precipitation during these months. A disturbance of moderate intensity extending from the 12th to the 15th April gave heavy snow in the Chitral and Kashmir Himalayas. The snowfall during the period from February to May was in moderate to considerable excess in the Western Himalayas, more especially in Kashmir and Chitral, where it was chiefly due to late and abnormally heavy falls in April and May, the excess being probably most marked on the interior and higher ranges.

(4) The chief feature of the season was the frequent snowfall in January, February and April over the whole of the Western Himalayas west of Nepal. The number of disturbances or storms was much larger than usual, but the storms were generally of feeble intensity and the accompanying precipitation light to moderate in amount. The fall was heavy in the Chitral, Kashmir and Punjab hills, but was very unequally distributed. Snow fell down occasionally to unusually low levels in April (5,000 feet) and May and caused extensions of the snow-clad surface in the hills for brief periods which affected the meteorological conditions in Upper India and, more especially, reduced temperature largely below the normal. The snow melted rapidly during the hot weather of the last fortnight of May and the snow-line on the 31st May was at a mean elevation of from 13,000 feet to 14,000 feet in the Punjab Himalayas and 15,000 feet in Ladakh.

(5) The snowfall of the past season up to the end of May was, so far as can be judged from the data, below the normal to a moderate extent in Persia, chiefly due to the early termination of the winter.

(6) The snowfall in Baluchistan was normal in amount and fell chiefly in November, December, January and February. It was hence favourable in all respects.

(7) The precipitation in Afghanistan was generally less than usual.

(8) The snowfall in Chitral was, so far as can be judged by a comparison of the past year with the previous three years, considerably below the normal in the earlier part of the winter, but was heavy in April and the first-half of May.

(9) The snowfall was heavier than usual in Kashmir. It commenced on the higher ranges somewhat earlier than usual. The chief feature was the heavy and late fall of the 13th, 14th, 20th and 21st April.

(10) In Chamba, Lahoul and the Simla hill states the winter commenced earlier than usual. Moderately heavy snow fell in the latter half of December, January and February and heavy and frequent snow in

April. The total snowfall of the season appears to have been considerably above the average in Chamba and the Simla hill states and in slight defect in Lahoul. The accumulation at the end of May was probably greater than usual, chiefly due to the abnormal prevalence of cloudy weather.

(11) The winter began earlier than usual in Kulu and the precipitation was above the normal during the winter up to the end of March. It was small in amount in April and May and the accumulation melted more rapidly than usual, as the depth of snow on the passes at the end of April was less than the average of past years.

(12) The snowfall in Kumaon and Garhwal during the period from the middle of December to the end of March was greater than usual and was about normal in April and May. The total fall of the season was hence above the normal to a moderate extent.

(13) No information has been received for Sikkim and Nepal.

(14) The information relative to the snowfall in the Assam Himalayas is as usual scanty, but appears to indicate that the fall was below the normal in that area. The deficiency was apparently most marked in Upper Assam and hence probably also in the hills to the north of Upper Burma.

ABNORMAL FEATURES OF THE METEOROLOGY OF INDIA DURING THE PREVIOUS EIGHTEEN MONTHS.

17. *Chief features of the meteorology in the cold and hot weather seasons, 1900.*—The meteorology of the dry monsoon (January to May) 1900 was very similar in several respects to that of the corresponding period of the past six years, in each of which the cold-weather precipitation has been more or less below the normal in North-Western India and the Persian area. The most important features of the meteorology of India during the first five months of 1900 were as follows:

(1) Weather was fine, dry and free from cold-weather storms in Afghanistan and Baluchistan in November and the first three weeks of December. A storm in the last week of the month gave moderate snow in Chitral and Kashmir. The first fortnight of January was unusually fine in the Persian area and Upper India. Two cold-weather storms affected Northern India in the second-half of the month. These storms gave heavy falls of snow in the Western Himalayas.

(2) The number of cold-weather storms was greater than usual in February, but they were, with one exception, the storm of the 16th to the 19th, feeble. March was unusually free from cold-weather storms. The precipitation of the two months was hence largely below the normal in the Persian area and North-Western India and the Western Himalayas. April was unusually disturbed and a large number of cold-weather storms, generally of slight intensity, affected the weather in Upper India and gave light to moderate snowfalls on the interior ranges. One storm, that of the 7th to the 10th, gave a heavy fall of snow in the North Afghan mountains, Chitral, Kashmir and the Punjab Himalayas. The snowfall during the period from February to April was in moderate to considerable excess in the Western Himalayas, chiefly due to late and abnormally heavy falls in April, the excess being probably most marked on the interior and higher ranges.

(3) The chief feature of the season was the frequent snowfall in April over the whole of the Western Himalayas west of Kumaon. The fall was very heavy in the Chitral, Kashmir and Punjab hills. Snow fell down occasionally to unusually low levels in April (5,000 feet) and caused extensions of the snow-clad surface in the hills for brief periods which affected the meteorological conditions in Upper India. The snow melted very rapidly during the hot weather of the last fortnight of May, and the snow-line on the 31st of May was at a mean elevation of from 13,000 feet to 14,000 feet in the Punjab Himalayas and 15,000 feet in Ladakh.

(4) The snowfall of the whole season from November 1899 to May 1900 was below the normal to a moderate extent in Persia and Afghanistan and Chitral, normal in Baluchistan, in moderate to considerable excess in Kashmir, and above the normal to a slight or moderate extent in the Punjab and Kumaon Himalayas and probably also in the Assam Himalayas.

(5) The snowfall accumulation in the last week of May 1900 was nowhere in large excess and was probably about normal in the Kashmir, Bushahr, Kumaon and Garhwal Himalayas and in Baluchistan and less than usual in the area including the Afghan and Chitral mountains and in Persia.

(6) The temperature and other meteorological conditions were chiefly related to the character of the storms of the period and the accompanying distribution of rain and snow in the Himalayan area. Temperature in North-Western India, for example, was in considerable to large excess in November, December, February and March and also in slight excess in May, but was more or less in defect in January and April. The most important feature of the temperature conditions was the very large excess in the Deccan, Berar and the Central Provinces from November to January. The chief feature of the pressure conditions was a marked tendency to deficient pressure in Northern India and to increased pressure in the Peninsula and North Bombay.

18. *Meteorology of India during the whole south-west monsoon period, 1900.*—The following gives a brief statement of the meteorology of India, month by month, during the whole south-west monsoon period June to December 1900:

June 1900.—The conditions in India at the beginning of June were, on the whole, favourable to the establishment of the monsoon in India and its rapid extension in the interior. Conditions were, however, unfavourable in the Arabian Sea and the Indian Ocean and the meteorological data collected from ships indicated that the south-east trades were at that time below their normal strength and hence that the full advance of the monsoon currents would be considerably delayed.

The south-west monsoon rains commenced considerably later than usual on the Malabar Coast on the 11th and 12th June and extended to the Konkan on the 13th and 14th, but were feeble for some time in that area. They began earlier than usual, but somewhat unsteadily in North-Eastern India. A moderate cyclonic storm formed in the Bay on the 10th and 11th and passed by a curved path through Orissa, the eastern districts of the Central Provinces and Chota Nagpur into North Bengal. Bengal and Assam received their first general rain from the Bay current on the 12th and Bihar on the 14th.

The first burst of monsoon winds in the Arabian Sea gave showers in the Deccan and Central Provinces on the 13th June and moderate to heavy rain in the coast districts during the next fortnight, when the rainfall was almost restricted to the coast districts and the West Deccan. The monsoon current in the Arabian Sea strengthened in the last week of the month, and heavy rain fell

in the Konkan on the 26th and following days. This burst of rain extended into the interior in the first week of July, the Central Provinces and Central India receiving their first general rain on the 6th July and the North-Western Provinces on the 6th and 7th.

The rainfall of the month of June was, on the whole, favourable in Burma and North-Eastern India or in the areas dependent on the Bay current, but was in large defect in North-Western and Central India, the Central Provinces, Berar and the North and East Deccan.

July.—The Bombay or Arabian Sea current was below its normal strength throughout the greater part of July, indicated chiefly by the delay in its advance towards Upper India and by the sporadic character of the rainfall in the Deccan and Central India. Gujarat and West and Central Rajputana had moderate to heavy rain for the first time in the second week of the month. The current, however, fell off rapidly in strength on the 18th and 19th and the rainfall was light and sporadic in Western India during the next week. Fortunately, conditions changed in the sea areas to the south of India on the 26th and 27th, antecedent to, and initiating, a strong and persistent advance of monsoon winds. Heavy rain again began to fall in the West Coast districts on the 27th July and extended to the Deccan and Gujarat on the 28th. Moderate to heavy rain fell in Gujarat, Kathiawar, the Central Provinces and Rajputana during the next week and also extended into the Punjab as heavy local showers.

The Bengal current was unsteady during the month of July and a succession of four storms formed in the north-west of the Bay. These storms advanced landwards along westerly and north-westerly tracks giving bursts of moderate to heavy rain in the areas in North-Eastern India traversed by them.

The rainfall of the month of July was generally above the normal over Bengal and Assam and the southern half of the Peninsula and was in moderate to largish defect in the North-Western Provinces, the Punjab, Rajputana, Central India, North Bombay, Berar and the Central Provinces.

August.—The conditions in August were very similar to those initiated during the last week of July. The Arabian Sea current was stronger and steadier than usual throughout the month and extended to its furthest limits in the Punjab during the greater part of the month. A succession of three storms formed in the north of the Bay, two of which advanced west-north-westwards through the Central Provinces and Central India into Rajputana and the third through Chota Nagpur and the eastern districts of the Central Provinces into the North-Western Provinces. These storms gave heavy rain to the areas they traversed, and the indraught to them diminished the rainfall in Assam, East Bengal and Burma and also in the West Coast districts and the Deccan.

The rainfall of the month was in slight to moderate excess in Burma, but was more or less below the normal in Assam and the greater part of Bengal, Bihar and the North-Western Provinces. It was in slight to large excess in the Punjab, Berar, the Central Provinces, Central India, Gujarat and Kathiawar and normal in the West Coast and the South and Central Deccan.

September.—The conditions in September were similar to those which obtained in August. A moderately strong and steady monsoon obtained in the Arabian Sea and a normal but somewhat unsteady monsoon in the Bay. Three cyclonic storms formed in the Bay and advanced into the North-Western Provinces, determining heavy rain to the areas in and near their tracks and diminishing the rainfall in the areas to the north and east outside the storm tracks.

The first storm was feeble, but gave a heavy burst of rain in Berar, the Central Provinces, Rajputana and Gujarat from the 5th to the 7th. The second disturbance of the month was the most remarkable of the year. Two cyclonic storms apparently followed each other across the Orissa Coast at an interval of two days. The second of these storms was absorbed by the first in the Central Provinces and the combined disturbance intensified and was almost

stationary for some days in that area. It finally advanced slowly into the North-Western Provinces and filled up in that area on the 28th. It gave an extraordinarily heavy downpour of rain in parts of South and West Bengal. Calcutta obtained a total of 40·35 inches during the week ending 8 A.M. of 25th September or 13·44 inches greater than the heaviest total rainfall hitherto recorded in any month (*viz.*, 26·91 inches in August 1844).

The rainfall of the month of September was hence very partially and irregularly distributed. The districts affected directly by the storms, including Lower Bengal, Orissa, Chota Nagpur, the Central Provinces, the North-Western Provinces, Central India and parts of Rajputana and the Punjab, obtained much heavier rain than usual. In Assam, the Deccan and Gujarat the rainfall of the month was, on the other hand, more or less below the average. Madras and Mysore had more frequent rain than usual.

October.—The meteorology of October and November was slightly abnormal, the chief feature being the early withdrawal of the retreating south-west monsoon current from the Bay. The Arabian Sea current apparently held steadily and strongly until nearly the end of September, but withdrew rapidly from its northern limits in the beginning of October and hence later than usual.

A storm formed in the centre of the Bay and passed by a curved path through the Central Provinces into Chota Nagpur and Bihar in the second week of October. It gave light to moderate rain in parts of the Central Provinces and North-Eastern India. Numerous showers fell in the south and centre of the Peninsula in the third week of the month.

A second and more severe storm formed in the Bay in the last week of the month and passed slowly westwards across the Coromandel Coast, near Madras, into the Peninsula. The course of this storm and the character of the rainfall indicated that the south-west monsoon was retreating much more rapidly southwards than usual.

The total rainfall of the month of October was in moderate to considerable defect in Burma, Bengal, Assam, Berar, the Central Provinces, the Konkan and the Bombay Deccan and in excess only in the south of the Peninsula. The deficiency was largish in North-Eastern India, the Konkan, the Deccan and North Madras and affected the rice crops to some extent.

Several feeble disturbances affected the Persian area, Upper India and the Kashmir and Punjab Himalayas in October and November. They gave much cloud and occasional snow in Persia, Baluchistan and Afghanistan. The precipitation was apparently heavier than usual in the Western Himalayas and Baluchistan, but was small in actual amount in Persia.

November.—The Bay monsoon current withdrew unusually early in November. Practically no rain fell in North-Eastern India, Burma, Assam and the Peninsula (except the extreme south) during the month. The rainfall of the month was hence exceptionally small in these areas and the deficiency was serious in some parts of the Deccan, affecting the crops very considerably. The rainfall of the month was in considerable to large defect in actual amount in the Coromandel Coast districts and in Central and South-Central Madras. Temperature hence fell much less rapidly than usual and was in moderate to large excess over the whole of North-Western and Central India and the Deccan area.

December.—The weather was more disturbed than usual in North-Western India by a succession of three cold-weather storms in the last fortnight of the month. These storms gave moderate rain over the plains of North-Western India and moderate to heavy snow in the hills. The precipitation was in considerable to large excess, relatively to the normal, in Persia, Baluchistan and North-Western India. Temperature was generally above the normal, more especially in a broad belt stretching across the head of the Peninsula, where it was 5° to 9° above the normal on the mean of the month. Southern India received occasional showers and the rainfall in that area was in slight to moderate defect.

19. *The rainfall of the south-west monsoon period proper 1900 (June to October)*.—The rainfall of the monsoon period (June to October) was from 20 to

52 per cent. below the normal in seven out of 56 rainfall divisions and less than 21 per cent. in 21 divisions. It was in excess in the remaining 26 rainfall divisions, but by more than 20 per cent. in seven divisions only. The four following tables give comparative data for the variation of rainfall in the 56 rainfall divisions grouped according to the amount of the excess or defect:

TABLE I.—*Comparative data for seven meteorological divisions in which the monsoon rainfall of 1900 was more than 20 per cent. in excess.*

Province.	Division.	Rainfall from 3rd June to 13th October 1900.			Variation expressed as a percentage.
		Average actual.	Average normal.	Variation from normal.	
		Inches.	Inches.	Inches.	
Bengal	Deltaic Bengal	61·75	45·40	+16·35	+36
	Orissa	58·41	45·60	+12·81	+28
Punjab	South-East Punjab	25·55	20·74	+ 4·81	+23
	South Punjab	18·36	13·13	+ 5·23	+40
	Punjab Submontane	36·14	23·29	+12·85	+55
Madras	Madras South-Central	32·47	24·83	+ 8·14	+33
Central Provinces	Central Provinces East	62·38	45·27	+17·11	+38

The rainfall of the period was hence in large excess in seven divisions, including three in the Punjab, two in Bengal and one each in Madras and the Central Provinces.

TABLE II.—*Comparative data for nineteen meteorological divisions in which the monsoon rainfall of 1900 was 20 per cent. or less in excess.*

Province.	Division.	Rainfall from 3rd June to 13th October 1900.			Variation expressed as a percentage.
		Average actual.	Average normal.	Variation from normal.	
		Inches.	Inches.	Inches.	
Burma	Tenasserim	157·70	152·38	+ 5·32	+ 3
	Lower Burma, Deltaic	93·59	79·89	+13·70	+17
	Central Burma	61·25	50·88	+10·37	+20
	Arakan	174·07	155·60	+18·47	+12
Bengal	Central Bengal	47·18	46·20	+ 0·98	+ 2
	Chota Nagpur	47·99	45·02	+ 2·97	+ 7
	North Bihar	46·07	44·52	+ 1·55	+ 3
Punjab	Central Punjab	16·48	13·97	+ 2·51	+18
	Punjab Hills	61·87	56·22	+ 5·65	+10
	North Punjab	14·45	12·06	+ 2·39	+20
Bombay and Coast (Madras).	Malabar	100·86	97·09	+ 3·77	+ 4
	Coorg	128·54	109·54	+19·00	+17
	Mysore	25·28	24·95	+ 0·33	+ 1
	Bombay Deccan	29·13	25·09	+ 4·04	+16

TABLE II.—*Comparative data for nineteen meteorological divisions in which the monsoon rainfall of 1900 was 20 per cent. or less in excess*—concld.

Province.	Division.	Rainfall from 3rd June to 13th October 1900.			Variation expressed as a percentage.
		Average actual.	Average normal.	Variation from normal.	
		Inches.	Inches.	Inches.	
Central Provinces	Central Provinces West	41·80	38·10	+ 3·70	+10
	„ „ Central	49·92	48·53	+ 1·39	+ 3
Bombay (North)	Kathiawar	23·42	19·71	+ 3·71	+19
Rajputana	West Rajputana	11·26	11·19	+ 0·07	+ 1
Madras	East Coast North	28·09	27·68	+ 0·41	+ 1

The preceding data hence indicate that the seasonal precipitation of the south-west monsoon of 1900 was in slight to moderate excess in the greater part of Burma, Bengal, the Punjab, the Central Provinces and Southern India (except the coast districts).

TABLE III.—*Comparative data for twenty-one meteorological divisions in which the monsoon rainfall of 1900 was 20 per cent. or less in defect.*

Province.	Division.	Rainfall from 3rd June to 13th October 1900.			Variation expressed as a percentage.
		Average actual.	Average normal.	Variation from normal.	
		Inches.	Inches.	Inches.	
Burma	Upper Burma	33·12	39·81	— 6·69	—17
Bengal and Assam	Eastern Bengal	68·33	72·01	— 3·68	— 5
	Assam Hills	92·44	113·84	—21·40	—19
	Bengal Hills	95·01	111·99	—16·98	—15
	South Bihar	36·39	38·08	— 1·69	— 4
North-Western Provinces and Oudh.	North-Western Provinces East.	32·17	35·40	— 3·23	— 9
	South Oudh	31·47	33·39	— 1·92	— 6
	North Oudh	34·21	35·99	— 1·78	— 5
	North-Western Provinces Central.	26 18	31·39	— 5·21	—17
	North-Western Provinces West.	23·93	24·06	— 0·13	— 1
	North-Western Provinces East Submontane.	37·09	38·48	— 1·39	— 4
	North-Western Provinces West Submontane.	35·00	38·82	— 3·82	—10
	North-Western Provinces Hills.	35·58	39·04	— 3·46	— 9
Bombay and Malabar Coast Districts.	Konkan	110·11	112·95	— 2·84	— 3
	Khandesh	19·52	22·79	— 3·27	—14
Berar	Berar	32·77	34·72	— 1·95	— 6
Rajputana and Central India.	Rajputana East and Central India West.	23·14	25·33	— 2·19	— 9
Madras	Madras Central	16·50	18·47	— 1·97	—11
	East Coast Central	16·55	18·24	— 1·69	— 9
	East Coast South	15·53	17·85	— 2·32	—13
	Madras South	8·07	8·28	— 0·21	— 3

The preceding data show that the rainfall of the period was below the normal by less than 20 per cent. in 21 divisions. The variations were less than 10 per cent. in 13 of these divisions.

TABLE IV.—*Comparative data for seven meteorological divisions in which the monsoon rainfall of 1900 was more than 20 per cent. in defect.*

Province.	Division.	Rainfall from 3rd June to 13th October 1900.			Variation expressed as a percentage.
		Average actual.	Average normal.	Variation from normal.	
		Inches.	Inches.	Inches.	
Bengal and Assam	Assam Surma	69·81	92·89	—23·08	—25
	„ Brahmaputra	44·44	56·55	—12·11	—21
	North Bengal	61·47	78 11	—16·64	—21
Punjab	West Punjab	3·50	5·86	— 2·36	—40
Bombay (North)	Gujarat	30·24	42·97	—12·73	—30
	Sind	2·66	4·29	— 1·63	—38
	Baluchistan Hills	1·07	2·25	— 1·18	—52

The rainfall of the period was more than 20 per cent. in defect in seven divisions, including three in Bengal and Assam, one in the Punjab and three in Bombay. It was in slight to large defect in Upper Burma, Assam, North and East Bengal, due to the large indraught of the Bay monsoon current in August and September to Upper India. It was also in moderate to large defect in a part of the Bombay Presidency, including Gujarat, Sind and Baluchistan and in the West Punjab, due to abnormal pressure conditions, the existence of which was noted in the June forecast.

The data of Tables I, II, III and IV show that the rainfall of the monsoon period of 1900 was above the normal in 26 divisions and below the normal in 28 out of 54 divisions of the Empire. On the average of the whole Empire it was almost exactly normal in amount. The area of greatest percentage deficiency included Baluchistan, the West Punjab, Sind and Gujarat in which the deficiency averaged 40 per cent.

20. *The rainfall of the retreating south-west monsoon period (October to December).*—The following table gives data of rainfall in the larger provinces from the 30th September to 29th December 1900.

Political Province or area.	Rainfall from 30th September to 29th December 1900.			
	Average actual.	Average normal.	Variation from normal.	Percentage variation from normal.
	Inches.	Inches.	Inches.	
Burma	7·62	10·53	— 2·91	— 28
Bengal and Assam	2·73	5·54	— 2·81	— 51
North-Western Provinces and Oudh	2·41	2·12	+ 0·29	+ 14
Punjab	1·08	1·00	+ 0·08	+ 8
Central Provinces	1·33	2·83	— 1·50	— 53
Berar	0·05	4·45	— 4·40	— 99
Rajputana and Central India	0·49	0·77	— 0·28	— 36
North Bombay	0·08	0·85	— 0·77	— 91
Bombay	1·01	6·41	— 5·40	— 84
Madras	10·41	14·92	— 4·51	— 30

The data of the preceding table show that practically no rain fell during the retreating south-west monsoon period, October to December, over Berar and North Bombay.

The rainfall of the period was in considerable to large defect in Burma, Bengal, Assam, the Central Provinces, Berar, Central India and the Bombay Coast districts. The deficiency was serious in parts of the Deccan where the crops were scanty and famine conditions prevailed.

There was a slight excess in the Punjab and North-Western Provinces, due chiefly to more frequent rain than usual from cold-weather storms in December.

The rainfall in the Madras Presidency was very unequally distributed, as is shown by the following statement:

Division.	Rainfall from 30th September to 29th December 1900.			
	Average actual.	Average normal.	Variation from normal.	Percentage variation from normal.
	Inches.	Inches.	Inches.	
Madras East Coast North . . .	6·95	12·49	—5·54	—44
Madras Central	3·67	8·62	—4·95	—57
Malabar	10·51	15·13	—4·62	—31
Madras South-Central	10·46	13·31	—2·85	—21
Madras East Coast Central . . .	7·70	16·30	—8·60	—53
„ „ „ South . . .	16·69	22·72	—6·03	—27
Madras South	15·86	15·86	+1·00	+6

The data indicate that the deficiency was relatively large in all the interior districts of Madras, averaging about 50 per cent. The precipitation in South Madras was normal and in Malabar and the Coromandel Coast districts it was in moderate to considerable defect and in the north coast districts in considerable defect.

The retreating monsoon withdrew much more rapidly than usual from the Bay and the period was characterized by the complete absence of severe cyclonic storms. The rainfall of the period was hence more or less below the normal over the Deccan and Madras Presidency except in the extreme south where occasional showers were received in December after the withdrawal of the south-west monsoon current.

21. *Chief features of the meteorology of India, January to May 1901.*—The following is a brief summary of the chief features of the meteorology of India during the past five months:

January.—A series of five depressions affected the weather in Northern India during the month, of which three probably formed over Kathiawar. They marched by more southerly tracks than is the usual rule in January. They gave cloudy weather and moderate rain over Northern and Central India. The third storm, that of 10th to the 15th, advanced from Persia and gave rise to a secondary depression in the Punjab. The double disturbance gave heavy snow in the hills and much rain in the plains of Northern India. The mean temperature of the month was below the normal to a moderate extent over the whole of Northern and Central India. It was, on the other hand, in excess in Burma and the Peninsula, the excess averaging 3° in South India and Lower Burma where it was greatest.

A noteworthy feature of the month was the abnormally cloudy weather in the Upper India hill districts. The precipitation of the month was normal or in excess over the whole of India and Lower Burma. The excess was very large, relatively to the normal, in Northern and Central India and the Deccan, where the rainfall of the month was from two to five times its normal amount.

February.—Weather was abnormally fine and settled in Persia and no cold-weather storms advanced into India from that area during the month. The conditions in India were, on the other hand, feebly unsettled throughout the month. Four shallow depressions formed over Khandesh or North Bombay and advanced across Central India They gave numerous thundershowers to Northern and Central India and the North Deccan. Three formed in Baluchistan or Upper India and marched eastwards across Northern India. These storms gave moderate rain over North-Western India. Although the storms were feeble, they were more numerous than usual and gave general and moderate rain. The rainfall of the month was hence in very large excess, relatively to the normal, over nearly the whole of India and Burma It is noteworthy that the rainfall was practically or absolutely *nil* in Lower Sind, West Rajputana, North Bombay and South Baluchistan, in which areas the depressions of the month originated.

The mean temperature of the month was in moderate excess in Southern India, Burma and Assam and was in slight to considerable defect in North-Western and Central India and the North Deccan.

Pressure was in local excess in Northern India and in local defect in the Deccan and Southern India and averaged ·020 inch above the normal for the whole of India.

March.—Weather was, as in February, finer than usual in Persia. Several cold weather storms affected Northern India. These storms originated either near the north-west frontier or in North Bombay. Four of the five storms were very feeble and gave only sporadic showers. The second storm of the series was a well-marked primary with a secondary in the Central and East Punjab. It gave moderate general rain over the greater part of Northern and Central India and heavy snow on the higher ranges. An important feature of the meteorology of the month was the very scanty rainfall in North-Eastern India, Assam and Upper and Central Burma. For example, Assam Surma received only an average of 1·23 inches, the normal fall of the month being 7·36 inches. The deficiency in the plains of North-Eastern India, Burma (except Lower Burma) and Assam ranged between 50 and 100 per cent.

The rainfall of the month was practically normal in amount in Upper and Central India, but was more or less in defect in Rajputana, Sind and Baluchistan.

The mean pressure of the Indian area was in general excess by amounts averaging ·045 inch. Pressure was, relatively to the general condition, in local excess in Northern and Central India and Upper Burma and was in defect elsewhere, more especially in the southern half of the Bay. Temperature was in slight to moderate excess to the west of the 77th meridian and also in Burma and Assam and was in defect in the intermediate area, more especially in Chota Nagpur and the eastern districts of the Central Provinces.

April.—Marked hot-weather conditions prevailed at the commencement of the month in North-Western India. Series of thunderstorms occurred during the first week in North-Eastern India and the Central Provinces. Pressure, which had been more or less in considerable excess ever since the middle of February, fell below the normal generally during the second week of the month. Strong westerly winds prevailed in the Peninsula and Central India. Assam received general and favourable rain. A disturbance of unusual character gave showers in the North Punjab and a heavy fall of snow in Chitral and the districts to the north on the 13th or 14th. This was followed by an intense cool wave which appeared in the North Punjab on the 14th and gradually extended eastwards and southwards during the next week, but diminishing in intensity. Frequent thundershowers were received in Assam during the week. Temperature increased above the normal in North-Western and Central India during the last week of the

month and strongly marked hot-weather conditions were re-established for a brief period in that area. Rain continued in Assam and extended to Bengal during the last week of the month. The chief feature of that period was a cyclonic storm in the Arabian Sea. It formed about the 25th in about Lat. 8° N. and Long. 60° E. and advanced in a general north-westerly direction, increasing in intensity during its northward march. The West Coast districts and parts of the Deccan received fairly general and moderate rain during the existence of the storm. The rainfall of the month was considerably below the normal in Burma. It was normal or in slight excess in Orissa, South and East Bengal and Assam, but was in largish defect in North Bengal. Practically no rain fell in the Gangetic Plain, Rajputana, Central India, North Bombay and Sind. The North Punjab received somewhat heavier rain than usual, but over the remainder of the Punjab the rainfall of the month was in moderate defect. The rainfall was practically normal over the greater part of the Deccan, Konkan and Southern India, but was in moderate excess in Malabar.

May.—Weather at the commencement of the month was disturbed with frequent thunderstorms in the Deccan area where temperature was hence very largely in defect. It was, on the other hand, remarkably dry in North-Eastern India. A disturbance of the cold-weather type affected Upper India on the 4th, 5th and 6th. It gave heavy rain in the North and North-East Punjab and severe snowstorms in the North Kashmir, including Chitral. It was followed by a cool wave of unusual intensity for some days. Temperature was from 15° to 20° below the normal in Baluchistan and the North Punjab on the 5th and 6th. Very dry cool weather hence prevailed in Northern and Central India until the 11th. Burma obtained series of thundershowers from the 9th to the 16th and Bengal from the 12th to the 21st and Southern India occasional local showers during the same period. A feeble cyclonic storm formed in the Bay on the 22nd and 23rd. It advanced by a curved path to the Akyab coast and gave moderate to heavy rain to Burma from the 23rd to the end of the month. Bengal received moderate rain on the 29th and two following days.

The mean pressure of the Indian area was ·013″ above the normal. It was in slight relative defect in Northern India and Burma and in slight relative excess in the Peninsula and Central India. The variations of the mean temperature conditions of the month from the normal were generally small and of little importance. Temperature was generally in slight excess, more especially in Rajputana and Upper Sind, where the excess averaged 2½°. It was in local defect in the North and Central Punjab by amounts averaging 3°.

The rainfall of the month was in moderate excess in Burma (16 per cent.) and in very large excess in the Punjab, more especially the northern and western districts. It was normal in amount in Sind, Rajputana, Gujarat and Madras, in slight defect in Bombay, the North-Western Provinces and Central Provinces and in considerable to large defect in Bengal and Assam.

22. *Larger abnormal features of the meteorology of India during the pre-monsoon period, 1901.*—The meteorology of India during the past five months has been characterized by strongly marked abnormal features.

The following states the most important:

(1) Pressure was from January to March in increasing excess over the Indian area and was normal in April and in slight excess in May, as is shown by the following statement:

Month.	Mean 8 A.M. pressure anomaly of Indian area.									
	1901.	1900.	1899.	1898.	1897.	1896.	1895.	1894.	1878.	1877.
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
January	+·011	—·004	—·003	+·017	—·003	—·003	—·009	—·020	+·030	+·073
February	+·020	—·008	—·040	—·077	—·036	—·012	+·009	+·010	+·033	+·051
March	+·045	+·006	—·010	—·013	—·020	—·022	—·018	—·017	+·044	+·037
April	—·004	+·022	—·001	—·017	+·038	—·032	+·013	—·019	+·037	+·066
May	+·013	+·061	—·019	—·008	—·005	+·013	—·007	—·023	+·032	+·041

(2) Pressure was from December to April in slight excess in Northern and Central India and Upper Burma as is the usual rule in periods of heavier cold and hot weather precipitation than usual. Pressure was, on the other hand, in slight defect in these areas in May. The following table gives data in illustration of this feature:

Area.	Mean 8 A.M. pressure anomaly in						Mean 8 A.M. pressure anomaly in May.
	December 1900.	January 1901.	February 1901.	March 1901.	April 1901.	Mean of period, December to April.	
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
Burma	+·004	—·004	—·007	+·012	+·003	+·002	—·015
Assam	+·001	—·006	—·001	+·007	+·001	0	—·011
Bengal	+·007	+·008	+·005	+·004	—·003	+·004	0
Behar	—·007	+·009	+·014	+·016	—·006	+·005	—·014
Chota Nagpur	+·016	—·002	+·016	+·016	+·010	+·011	—·001
North-Western Provinces	+·003	+·009	+·017	+·018	+·002	+·010	—·010
Punjab	+·009	+·004	+·022	+·010	+·020	+·013	—·005
Rajputana	—·016	+·004	+·001	+·003	—·001	—·002	+·003
Sind	+·011	+·002	+·023	—·013	+·003	+·005	—·003
Central India	—·015	+·002	+·003	+·009	+·005	+·001	—·001

(3) The pressure variations in the Peninsula, excluding Berar and the Central Provinces were throughout the period generally opposite in character to those in Northern India; or, in other words, they were negative from December to April and positive in May. The following gives data:

Area.	Mean 8 A.M. pressure anomaly in						Mean 8 A.M. pressure anomaly in May.
	December 1900.	January 1901.	February 1901.	March 1901.	April 1901.	Mean of December to April.	
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
Gujarat	—·026	0	+·017	—·019	—·022	—·010	+·014
West Coast	—·009	—·002	—·018	—·032	—·019	—·016	+·015
Bombay Deccan	—·014	—·007	—·020	—·011	—·006	—·012	+·012
Mysore	—·001	—·004	—·019	—·017	—·006	—·009	+·013
Madras Coast	+·012	—·003	—·017	+·002	+·011	+·001	+·008
Madras Deccan	+·006	—·021	—·022	+·005	—·007	—·007	+·007
South India	+·011	—·008	—·037	—·022	—·005	—·012	0
Ceylon (Colombo)	+·003	0	—·034	—·046	—·023	—·020	—·007

(4) In the intermediate belt between these two large areas of opposite variations of pressure, pressure was throughout the period January to May in slight local excess, as shown below:

Area.	Mean 8 A.M. pressure anomaly in						Mean 8 A.M. pressure anomaly in May 1901.
	December 1900.	January 1901.	February 1901.	March 1901.	April 1901.	Mean of period, December to April 1901.	
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
Central Provinces	—·011	+·002	—·004	+·016	+·005	+002	+·004
Berar	—·010	+·003	+·006	+·014	+·011	+·005	+·014

(5) Pressure was generally in relative defect at the hill stations or the vertical pressure anomalies were negative in the months of most disturbed weather in Upper India, including December, January, February and April. They were, on the other hand, generally positive in March and May, as is almost invariably the case in months of greater temperature than usual in the hot season. The following gives data for six pairs of stations:

Pairs of stations.	Mean 8 A.M. vertical pressure anomaly in					Mean of period, January to May 1901.
	January 1901.	February 1901.	March 1901.	April 1901.	May 1901.	
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
Leh and Lahore . . .	—·068	+·013	+·034	—·033	+·003	—·010
Simla and Ludhiana . . .	—·053	—·033	—·008	—·001	+·020	—·015
Murree and Peshawar . .	—·017	+·006	+·024	—·013	—·003	—·001
Chakrata and Roorkee . .	—·042	—·025	—·025	—·006	+·020	—·016
Ranikhet and Bareilly . .	—·026	—·002	—·010	+·010	+·012	—·003
Quetta and Jacobabad . .	—·024	+·001	+·049	+·024	+·036	+·017

(6) Temperature was in general defect in Extra Tropical India in January and February. It was in general excess in March, except in North-Eastern India, where it was in slight to moderate defect. It was, on the contrary, in slight excess in that area in April and in slight to moderate defect in North-Western and Central India. It was in general excess in May, the excess being most marked in Central and North-Western India. The following gives data:

Area.	Variation from normal of mean daily temperature.						
	December 1900.	January 1901.	February 1901.	March 1901.	April 1901.	Mean of period, January to April.	May 1901.
	°	°	°	°	°	°	°
Burma	—0·9	+1·9	+2·2	+0·7	+1·7	+1·1	+0·2
Assam	+0·8	—1·1	+2·3	+0·5	+0·1	+0·5	+1·1
Bengal	+0·3	—1·6	+1·6	—0·2	+1·4	+0·3	+1·1
Orissa	+4·6	—1·4	—0·8	—1·0	+0·5	+0·4	+0·4
Bihar	+1·7	—2·0	+0·8	—1·8	+0·4	—0·2	+1·1
Chota Nagpur	+4·8	—3·0	—0·6	—2·2	—0·5	—0·3	+0·7
N.-W. P. and Oudh	+1·4	—2·7	—0·7	—1·5	—1·7	—1·0	+0·2
Punjab	—0·4	—2·2	—1·0	+0·3	—2·7	—1·0	—1·4
Sind	0	—1·7	—3·3	+2·6	+1·1	—0·3	+1·5
Rajputana	+1·4	—2·7	—1·7	+1·1	—0·5	—0·5	+2·2
Gujarat	+2·9	—1·9	—1·9	+1·8	+1·2	+0·4	+0·4
Central India	+6·0	—2·6	—1·5	+0·3	—1·0	+0·2	+1·7
Central Provinces	+8·9	—1·1	—1·7	—1·7	—0·8	+0·7	+1·1
Berar	+8·7	—0·1	—2·2	—0·4	—0·2	+1·2	+1·6

(7) In Tropical India the variations of temperature from the normal were, as a rule, generally opposite in character to those in Extra Tropical India. Temperature was in excess from December to April, the variations being large in January and February. It was, on the other hand, in slight defect in May. The following gives data :

Area.	Variation from normal of mean daily temperature.						
	December 1900.	January 1901.	February 1901.	March 1901.	April 1901.	Mean of period, December to April.	May 1901.
West Coast	°+1·9	°+0·8	°+0·3	°+1·0	°+1·0	°+1·0	°+0·7
Bombay Deccan	+5·8	+1·9	—2·3	+1·0	+0·3	+1·3	—0·2
Mysore	+2·5	+4·1	+2·3	+0·1	+1·3	+2·1	—0·2
Madras Coast	+0·7	+2·7	+1·4	—0·6	—0·2	+0·8	—0·1
Madras Deccan	+2·5	+4·1	+1·1	—0·7	+0·7	+1·5	—1·5
South India	—0·2	+2·9	+3·1	—0·6	+0·1	+1·1	+0·1

(8) The air has been much damper than usual during the greater part of the period over nearly the whole of the interior and more especially in North-Western India, Berar, the Central Provinces and the Deccan. The air was generally drier in November and of normal or slightly increased humidity in December. During the period (January to April) it was in general excess. The following gives comparative data for nine representative stations :

Station.	Variation from normal of mean relative humidity (*i.e.*, percentage of saturation.)						Mean of period.
	November 1900.	December 1900.	January 1901.	February 1901.	March 1901.	April 1901.	
Hazaribagh	?	+13	+15	+21	+6	—1	+11
Allahabad	—2	+1	+11	+8	+6	+2	+4
Lahore	+9	+16	+13	+10	+6	+5	+10
Jaipur	0	+8	+8	+6	—1	—6	+3
Jacobabad	+6	+16	+9	+1	—1	—5	+4
Quetta	+19	+14	+15	—6	—4	+1	+7
Nagpur	—5	+7	+9	+12	+15	+14	+9
Belgaum	—10	0	+5	+10	+3	+7	+3
Bellary	—11	—7	—5	+10	+2	—4	—3

(9) The distribution of the cold and hot weather precipitation has been abnormal. The rainfall of the cold weather was more or less in excess over the whole of India with the exception of Assam and Sind. The excess was very large in the Gangetic Plain, Chota Nagpur, Orissa, the Central Provinces and Berar in which the rainfall averaged from two to five times its normal amount. It was in considerable to large defect, relatively to the normal, in the hot weather period in North-Eastern India, Central India and Rajputana. It was, on the other hand, in large excess in the

Punjab and in moderate excess in Berar and Gujarat. The following table gives comparative data showing the character and distribution of the rainfall of the two periods:

Province or Division.	Cold-weather rainfall (January and February 1901).				Hot-weather rainfall (from 3rd March to 26th May 1901).			
	Average actual.	Average normal.	Variation from normal.	Percentage variation from normal.	Average actual.	Average normal.	Variation from normal.	Percentage variation from normal.
	Inches.	Inches.	Inches.		Inches.	Inches.	Inches.	
Burma	1·66	0·21	+1·45	+690	6·69	11 67	—4·98	—43
Assam	1·19	2·25	—1 06	—47	16·48	29·37	—12·89	—44
Bengal	1·68	1·34	+0·34	+25	7·38	10·78	—3·40	—32
Bihar	2 89	1·26	+1·63	+129	1·87	2·65	—0·78	—29
Chota Nagpur	6·41	1·42	+4·99	+351	3·42	3·66	—0·24	—7
Orissa	4·34	1·16	+3·18	+274	4·38	5·29	—0·91	—17
North-Western Provinces and Oudh	3·57	1·17	+2·40	+205	0·74	1·15	—0·41	—36
Punjab	3·06	1 89	+1·17	+62	3·43	2·19	+1·24	+57
Sind	0·35	0·71	—0·36	—51	0·53	0·43	+0·10	+23
Rajputana	0 88	0·56	+0·32	+57	0·31	0·90	—0·59	—66
Central India	1·75	0 96	+0·79	+82	0·49	0·85	—0·36	—42
Gujarat	0·12	0·08	+0·04	+50	0·22	0·17	+0 05	+29
Central Provinces	3·90	0·79	+3·11	+394	1·27	1·25	+0·02	+2
Berar	2·27	0 65	+1·62	+249	0·98	0·64	+0·34	+53

SUMMARY OF THE CHIEF FEATURES OF THE METEOROLOGY OF THE SOUTH-WEST MONSOON PERIOD OF 1900 AND OF THE COLD AND HOT WEATHER PERIODS OF THE PRESENT YEAR.

23. The chief features of the meteorology of the south-west or wet monsoon period of 1900 were as follows:

(1) The contrast between the steadiness and strength of the two branches of the monsoon currents. The Bay current was strong and steady in June and July and unsteady and somewhat feebler than usual in August and Septemher. The Bombay current was, on the other hand, feeble and unsteady in June and July and was remarkably steady and much stronger than usual in August and September. The Bombay current was not established in full strength until nearly the end of July.

(2) The rains, although very irregularly distributed in time, were practically normal in amount over the greater part of Northern and Central India. They were deficient chiefly in the West Deccan and Gujarat. The deficiency was serious only in the Bombay Deccan area.

(3) The termination of the monsoon rains in North-Western and Central India, occurred slightly later than usual, in Bengal about the normal date and in Burma earlier than usual in the first week of November.

(4) The retreating south-west monsoon gave moderate rain to the Peninsula south of Lat. 12° N., *i.e.*, South Madras, Mysore and the North Madras coast. The rainfall during this period was scanty in the Deccan area.

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24. The chief features of the meteorology of the past five months may be summed up as follows :—

(1) The winter rains and snowfall commenced earlier than usual in the Persian area and Western Himalayas. They ceased slightly earlier than the normal date in Persia and Baluchistan The precipitation was in defect in Persia and normal in Baluchistan.

(2) The winter was more severe and prolonged than usual in Chitral, Kashmir and the Punjab and North-Western Provinces Himalayas. The chief features were the excessive precipitation in the middle and lower ranges from Simla to Garhwal and the late snowfall in Chitral and Kashmir in April and the first fortnight of May.

(3) The snow accumulation was probably slightly above the normal in the Western Himalayas at the end of May.

(4) The snowfall in the Eastern Himalayas was more or less considerably below the normal.

(5) During the whole period from January to May the variations of the meteorological conditions from the normal in extra Tropical India were opposite in character to those in Tropical India or more exactly in India to the south of the 20th parallel of latitude.

(6) The more important meteorological conditions of the first four months of the year were opposite in character to those of the month of May.

(7) The variations in the first four months of the year were such as are almost invariably associated with a more severe winter and larger snowfall than usual in the Western Himalayas, *viz.*, excess of pressure, deficiency of temperature and heavier rain than usual in Extra Tropical India and increased temperature and deficient pressure in Tropical India. The variations were not large and hence were in agreement with the character of the snowfall.

(8) In the month of May temperature was in general excess and pressure in equally general defect in Northern India. Temperature was, on the other hand, in defect and pressure in excess over a considerable part of the Peninsula. These variations almost invariably obtain in hot weather seasons of years of light snowfall. They were not very strongly marked in the present case, but indicate that the effect of the winter snowfall on the weather conditions in India had practically ceased before the end of the month.

(9) The local variations of the pressure conditions from the normal have been throughout comparatively small. The only important features in May were a moderate excess in Western India and a moderate deficiency in Lower Burma and the Andamans. The most important feature of the general pressure conditions in May over the whole Indian monsoon area was the very slight variation from the normal conditions, in which respect they agreed closely with those of the corresponding month of 1900 (*vide* last year's forecast).

(10) It may be noted that the meteorology of the past two months has been very abnormal in many respects. There appears to have been more frequent and severe series of nor'westers and hailstorms. A severe cyclonic storm formed unusually early in the season in the south-east of the Arabian Sea in the fourth week of April and advanced north-westwards to the Arabian Coast. The most remarkable feature was a storm unique in its occurrence which gave a deluge of rain in the west and north-west frontier districts of the Punjab and the adjacent districts of Afghanistan in the first week of May.

COMPARISON WITH PREVIOUS YEARS.

25. Comparison with previous years is of little value as a guide unless the resemblances are strongly marked. The following gives brief descriptions of the

years 1878, 1891, 1898 and 1900 which resemble the present year in some respects. The resemblance was most pronounced in the years 1878 and 1900:

1878.—Very heavy snow fell in the Kashmir and Punjab Himalayas in January, February, April and May, and there was a very large accumulation of snow in the Kashmir Himalayas at the end of May. Temperature in North-Western India was above the normal in February and March and was slightly below it in April and very largely below in May (4° to 7° in the Punjab). The chief feature of the cold weather was the excessive snowfall in Kashmir in the latter part of May which occurred during a period of very stormy weather generally in Upper India. Pressure was steadily in defect in the Peninsula, Central India, Rajputana and Sind during the pre-monsoon period, the deficiency being greatest on the West Coast and was considerably in excess locally in Bengal and Assam.

The monsoon rains were very late in setting in and June was a very dry month. They were abundant in July, August and September, and every part of India received rainfall in excess of the normal, except Bihar, the North-Western Provinces and Central India in which there was a moderate deficiency and Burma in which there was a deficiency ranging from 10 to 20 per cent. in amount. The rainfall was especially abundant in Gujarat, the Konkan, Mysore, the Deccan and Berar. A noteworthy feature of the south-west monsoon was the excessive rain in the areas which usually receive their rainfall from the Bombay current and the very deficient rainfall in Burma.

The rainfall of September was practically normal in amount. The monsoon currents withdrew from Upper India in the fourth week of September.

The retreating south-west monsoon rains were slightly more abundant than usual, more especially in Burma.

1891.—The snowfall in the mountain regions of Baluchistan and Afghanistan was very much above the average. The winter began early in November 1890 and continued unusually late, and snow fell at frequent intervals and in large amounts during the whole of that period. The winter was exceptionally severe and prolonged in the Western Himalayas (bordering the Punjab and North-Western Provinces) The first considerable snowfall occurred in November, and snow fell more or less steadily throughout the whole season up to nearly the end of May. The amount received in the lower ranges was generally (except in the North Punjab) not much greater than usual, but on the higher and interior ranges it was excessive.

Pressure was steadily in excess from January to May 1891 over the Indian area by amounts averaging ·017 inch. Pressure was locally in excess in North-Western India, the excess increasing from January to May. The excess was most pronounced in the Indus Valley and Baluchistan. Pressure was, on the other hand, locally in defect in Burma, Assam and the Peninsula.

The temperature conditions were as marked as the pressure conditions. Temperature was during the period (January to May) steadily below the average in Northern and Central India and above it in Burma and the Peninsula. The deficiency in Northern India increased until the month of March, in which month temperature was 6° in defect over the greater part of North-Western India. Temperature decreased throughout April and May, and at the end of the latter month it was slightly above the average in North-Western India and increasing rapidly. The excessive temperature over the Peninsula and North-Eastern India was most marked in Burma, and the excess increased from January until May, when the mean of the month was upwards of 4° above the normal over the greater part of that province.

The south-west monsoon of 1891 was greatly delayed and was not fully established on the Bombay Coast until nearly the end of June. In the North-Western Provinces and East Punjab the rains did not set in properly until the last week of July. Notwithstanding this prolonged delay in the establishment of the monsoon currents in Upper India, the rainfall of the monsoon period was very largely in excess in the large area, including the North-Western Provinces, the eastern districts of Rajputana, Central India and the Central Provinces, due chiefly to steady heavy rainfall in the months of August and September.

The great indraught of the monsoon currents to this area of excessive rainfall diminished the rainfall in the remainder of India—more especially in West

and Central Rajputana and North Bengal and Bihar—and the rains practically failed in West and Central Rajputana. The rains ceased almost simultaneously over the whole of Northern and Central India at the beginning of the second week of October (from the 5th to 8th), and the area of heavy general rainfall was immediately transferred to South Madras, which continued to receive moderate to heavy rain during the next two months.

1898.—The weather was less disturbed and drier than usual in January. It was, on the other hand, somewhat more unsettled than usual in February in North-Western India, and the precipitation of the month was generally above the normal in the plains of India. The snowfall of the winter of 1897-98 was much less than usual over the whole of the Western Himalayas and probably also in Afghanistan, Chitral and in Baluchistan. The hot weather was even drier than usual over nearly the whole of India. There was a heavy and somewhat abnormal fall of snow in the second week of May over the whole of the Western Himalayas.

The south-west monsoon currents were, on the whole, favourable as rain-distributing winds. The rains commenced on the 9th and 10th (somewhat later than usual) on the Malabar and Konkan Coasts. They began on the 16th on the Bengal Coast and hence about the normal date. The humid currents extended rapidly into the interior and gave general rain from the 14th to the 18th. The first burst in the Arabian Sea was, however, feeble and the current withdrew temporarily from Upper India on the 19th. A short break obtained over the whole country from the 25th to the 28th when rain re-commenced. Both currents gave satisfactory rain in July. The Bombay current was weak in August and was determined more largely than usual to the Peninsula and North-East India in September.

The rainfall of the monsoon period was in moderate excess in North-East India, normal in the Peninsula and more or less in defect in North-West India.

1900.—Heavy snow fell in the Western Himalayas in February and frequent snow in April and the first half of May, occasionally down to 5,000 feet. January and March were, on the other hand, drier than usual. The winter snowfall was probably in moderate excess on the higher ranges in Kashmir and Chitral and in Kumaon and perhaps the Assam Himalayas.

The first advance of the monsoon current in the Arabian Sea took place at the end of the second week in June. It was, however, weak and failed to extend beyond Bombay. The current was feeble during the next month, and it was not until the last week of July that the humid currents penetrated to Upper India. The Bombay current was very strong in August, moderately strong in September and withdrew from Upper India somewhat later than usual.

The rainfall due to the Bombay current was abundant on the West Coast, normal in the Central Provinces, Central India and Rajputana and in slight to moderate defect in the interior of the Peninsula.

The Bengal current was above its normal strength throughout the greater part of the season and gave favourable rain to Burma and North-Eastern India. The rainfall of the season was normal in amount in the Punjab and North-Western Provinces where, however, it occurred chiefly in August and September.

GENERAL CONDITIONS IN THE INDIA MONSOON AREA, SOUTH AFRICA AND THE INDIAN OCEAN.

26. Theory indicates that any large and persistent variation in the strength of the south-east trades would be reproduced in the strength of the south-west monsoon. A variation in the strength of the south-east trades was probably the chief or primary factor in determining the variations in the south-west monsoon in India during the past year—more especially the weakness of the Arabian Sea current in the early part of the monsoon period and its strength in the months of August and September. It is hence desirable to ascertain the chief meteorological features of the areas dominated by the south-east trades during the past three or four months, in the hope that this information may give a valuable indication at the present time of the probable general strength of the approaching monsoon. The following is a summary of the information received, partly by letter and partly by telegrams, from South Africa, the Seychelles, Zanzibar, Mauritius and Cape Town and partly from the logs of ships regarding this important factor.

27. *South Africa*.—The following interesting summary of the weather in South Africa from November to April has been received from Mr. Hutchins, Conservator of Forests, Cape Colony:

"I attach a statement showing percentage of rainfall at various selected stations in South Africa for this summer south east season October to March. The weather for this period, influenced possibly by the abnormal condition of the sun, shows peculiar and abnormal features. During October the weather was nearly normal, though some slight excess rainfall at western stations (rising to as much as 142 per cent. at Ceres the highest and wettest of the inland western stations), and light drought at eastern stations show a slightly delayed arrival of the south-east trade.

"During November heavy south-easters began to prevail, bringing down the rainfall at western stations to a little below the average, but not as yet affecting the eastern stations. During December the south-easters, as I think I mentioned in my last note to you, blew with terrific force in the Cape Peninsula and at the western stations, and their effect made itself felt in the increased rainfall which you will see in the statement attached beginning at Robertson in the south-west of Cape Colony and extending right across the sub-continent to Salisbury. Kimberley and Durban with their rainfall rather below the average are local exceptions. On the shores of False Bay the south-east wind was stronger than at any time since 1895. Early in January, however, there came a change ushering in the peculiar feature of the season. The strong south-east winds began to take on a cyclonic character and during the month three depressions, altogether abnormal for the time of the year in their depth and strength, passed across from east to west. These depressions had the character of those of higher latitudes; in fact, they were deeper and stronger than we usually get during winter. (Our summer depressions are usually shallow and weak.) The first of these deep depressions passed during the last week in December. On the 15th of January the barometer fell to 29·683″ at the Royal Observatory, Cape Town, and to 29·472″ at Agulhas, our most southerly station. Soaking rains, altogether unprecedented for the time of the year, fell, as the barometer rose—as much as five inches rain in one day, at Kenilworth near Cape Town where I live. This surpasses, not only all summer, but all winter records. The rain was equally heavy in proportion all over the south-west of Cape Colony, but it is noticeable that on Table Mountain between 2,000 and 3,000 feet the rain was not so heavy in proportion. After this memorable 15th of January, the barometer did not rise much and on the 18th came another fall nearly as remarkable.

"Rain again fell in torrents in Cape Town and the suburbs. These depressions seem to have been what the Australians call Antarctic with the following features of high latitude depressions:

(1) Rain before the bottom of the barograph curve instead of, as usual, after it.
(2) Unusual depth even for winter.
(3) Wind-veer before the barometer movement instead of, as is normally the case here, after it.

"The following statements extracted from the *Cape Argus* of the 20th January have been verified:

"'The rainfall this month has already beaten the record, which at the Royal Observatory goes back to 1842. Up to 9 A.M. on the 19th instant the gauge at the Royal Observatory registered 3·31 inches which fell as follows:

	Inches.
January 5—6	0·34
„ 6—7	0·18
„ 19—10	0·18
„ 15—16	1·28
„ 18—19	1·33
Total	3·31

"'The total rainfall in January has only exceeded 2 inches on three occasions, namely, in 1850, 2·07 inches; 1846, 2·41 inches, and the old record in 1845 of 3·18 inches. It will be thus seen that the record has been easily broken this year with 13 days yet to spare. The average rainfall for this month of the last ten years was only 0·56 inch. It is not unusual for the rainfall to be less than a tenth of an inch in this month, and sometimes there is none at all.'

"This abnormal weather continued during January and died away during the early part of February. Remarkably low temperatures prevailed during January and February as the result of the abnormal storms and rain. It was remarked that the sun seemed powerless to ripen the grapes which hung rotting in the vineyards. During January the average rainfall at seven selected average stations in the Cape Peninsula was sixteen times the normal. This heavy rain extended inland, as mentioned, over the south-west of the continent. It flooded rivers and ruined the grape crop as is shown by the following extractfrom the *Cape Times:*

"'*Hermon, January 19th.*—The weather is most miserable and unseasonable, the rainfall being more than in any winter month. The Berg River has been in flood for days, and the grape and sweet potatoes and garden crops along the river will be greatly damaged, if not totally ruined.'

"At Ceres there fell seventeen times the average: at Drakenstein, near Paarl, twelve times the average. At the same time, exactly as happens with winter storms, the south-east of the Colony showed a deficient rainfall, though not to a great extent. Durban and East London on the coast (as also usually happens with these storms) show little or no deficient rainfall. Durban shows the effect of the storms in a low average barometer. Rhodesia, as we shall see presently, was not touched by them.

"After the early days of February up till now, the weather may be described as normal, with, generally, a moderate excess of south-east wind strength, bringing good rains to all that part of the continent watered by the south-east summer rainfall. Magistrates' reports in the Transkei, Halse at Cernarvon, Forest Officers' reports at Hanover, etc., concur in this. (See also the rainfall return.) An observer at Port Elizabeth remarks on the extraordinary preponderance of south-east winds there during February and March. During the last three weeks there has been a noticeable absence of the early winter storms which should have begun to make themselves felt at this season. The barograph shows a gently undulating line, and thus the storms which we had in such extraordinary excess in January are now in defect. Durban and Kimberley seem now getting the rains which most other places got earlier. At Kimberley the weather has been summed up to me in a telegram as being this year two months late."

"At Port Nolloth this summer the wind is described as about the normal. This is a practically rainless locality.

"The above relates to Cape Colony and Natal. From Orange River Colony and the Transvaal I have no figures, but in Rhodesia, Salisbury shows a rainfall of 41 inches to the end of March with a heavy excess during January. Buluwayo rainfall is 24 inches to the end of March which is rather above the average.

"The good south-east summer rains of this year were predicted in my annual forecast; the extraordinary storms of January were not. Possibly they were caused by the same solar influence which Sir Norman Lockyer holds caused the last Indian famine, *vide* his paper on Sunspot influence read before the Royal Society in November last.

"To resume, south-east winds and rain have this summer been generally above the average, but unsteady. The unprecedented storms of January on the southern coast suggest the continuance of those abnormal solar conditions which Sir Norman Lockyer holds caused the last Indian famine."

Percentage variation of rainfall from November to March at 29 stations in South Africa :

Name of station.	Month.					
	October.	November.	December.	January.	February.	March.
Royal Observatory	+ 52	— 17	— 33	+1,141	— 14	— 69
Rondebosch	+ 48	+ 33	+ 46	+1,418	+ 33	— 45
Kenilworth	+ 80	— 40	— 3	+2,409	+ 34	— 49
Tokai	+ 32	— 55	— 14	+ 877	+ 83	— 58
Strandfontein	+ 31	— 42	— 26	+ 913		
Eerste River	+ 3	— 71	— 80	+4,460	+ 61	— 67
Peak	+ 28	— 2	+ 23	+ 185	+ 34	
Average Cape Peninsula	+ 39	— 32	— 52	+1,629	— 41	— 57
Robertson	+ 24	+ 3	+111	+ 457	+222	—100
Clamvilliam	+186	+112	+244	+6,233	— 67	— 7
Swellendam	— 22	— 12	+179	+ 18	+178	— 80
Riversdale	— 12	— 56	+ 44	— 31	+196	— 66
Grootvader's Bosch	— 55	— 47	+196	+ 73	+214	— 94
Cues Road	+ 15	— 40	— 32	+ 719	+ 64	
Cues	+142	+ 23	+ 81	+1,715	+136	— 49
Calvinia	+100	— 67	+ 77			
Carnarvon	— 78	—100	+110	— 97	+191	+ 14
Victoria West	—100	— 64	+242	— 93	+ 68	+ 20
Hanover	—100	—100	+220	— 100	+ 47	— 19
Kimberley	+ 6	— 80	— 18	— 74	— 2	+123
Aliwal North	— 70	—100	+ 20	— 100	— 4	— 22
Evelyn Valley	+ 6	— 39	+195	— 55	+ 50	
Hogsback	— 38	— 39	+ 10	— 50	+ 39	
East London	+ 33	— 48	+156	— 10	+ 71	
Grahamstown	— 41	— 78	+164	— 52	+ 40	— 3
Umtata	— 64	— 63	+116	+ 5	— 10	— 22
Buttersworth	— 26	— 75	+220	— 68	— 9	— 4
Port St. John's	— 52	— 60	+ 60	— 64	— 26	+ 17
Kokstad	— 48	— 80	+ 11	— 57	— 7	— 33
Durban	— 26	— 17	— 40	+ 45	— 32	+114
Salisbury	+ 40	—100	+257	+1,425	+513	

The following telegram giving the weather from middle of April to the 25th of May was sent by Mr. Hutchins on the 25th:

"The south-east trades were above their average strength this summer, but were unsteady. There were series of storms of unprecedented strength in January. These conditions appear to point to the continuance of the solar disturbing influence which Sir Norman Lockyer maintains caused the last Indian famine. The weather since the middle of April has been characterized by a somewhat early decline of the south-east trades and by the early setting in of winter, at least two weeks earlier than usual with the appearance of a deep depression of the winter type and heavy rain on the 12th. The following gives the variation of the rainfall from the normal in April in the chief districts of the Cape Colony:

Western districts, 51 per cent. in defect;

South Coast districts, 26 per cent. in defect;

Eastern districts, 29 per cent. in defect;

Karoo, 86 per cent. in excess; and

Kimberley, 11 per cent. in excess.

At Durban the weather and rainfall of the month were practically normal; at Bulwayo weather is abnormally fine and cold and at Salisbury it is drier than the normal, but not so dry as in the corresponding period of last year.

Mr. Hutchins finally telegraphs on the 1st June: "Early winter rains continue at Cape Town. Seven inches of rain fell last week in the suburbs of Cape Town."

28. *Central Africa.*—The rains commenced in Lat. 5° in the Soudan about the end of March. Broken weather with thunderstorms obtained as far north as Lat. 10° N. in April. The rains in that district are said to be earlier than last year. According to telegraphic information published recently in Indian Newspapers, the Nile began to rise at Khartum on the 1st May, and there appears to be every probability of a fair Nile flood this year. The Victoria Nyanza is reported to have risen two feet above the highest recorded water-mark.

A telegram, dated the 1st June, received from Cairo, states that stations in the Soudan south of Khartum report southerly winds and the prevalence of thunderstorms with rain during the preceding fifteen days.

29. *Seychelles.*—The weather telegrams received from this station in May show that pressure was slightly lower than usual. Winds were much stronger than usual and were steady and normal in direction. The mean air movement of the month averaged about 70 per cent. above the normal. The rainfall of the month was slightly above the normal. At the end of the month pressure and other conditions were normal.

30. *Zanzibar.*—The observations recorded at this station in April show that trade winds obtained throughout the month and were giving considerably heavier rain than usual. The total rainfall of the month was 18·10 inches, or practically 50 per cent. above the normal of the month (12·2 inches). The winds were, on the average of the month, about 10 per cent. above their normal intensity and were slightly more westerly than usual. Pressure in May as in April was below the normal, the greatest deficiency occurring in the second week of the month. Winds were throughout the month more westerly than usual (from S.S.W., instead of from S. 5° E.). The wind velocity was also throughout the month above the normal by amounts averaging 20 per cent. The rainfall was excessive, the total amount from the 4th to the end of the month being 17 inches, or double the normal fall of the month which is only 8·8 inches. Weather was during the greater part of the month squally and more stormy than usual.

31. *Mauritius.*—The information from this island is less than usual, but agrees in its main features with the weather during the same period in South

Africa. Pressure was above the normal in January and February, but was below it in March, April and May, the deficiency being greatest in April. Winds were slightly stronger during the last fortnight of May, but were very unsteady. Conditions are reported to have been abnormal for some time past and the weather in May resembled that which usually obtains in April.

32. *Information derived from ships entering the Ports of Bombay and Calcutta.*—The information received from ship's logs is very scanty. The data obtained from four or five vessels from the Cape or Mauritius to Bombay show that in the latter half of May the south-east trades were strong and probably stronger than usual in the south and west of their usual area of extension in May, but were somewhat weak and unsteady with squally variable weather in the central area to the south of Ceylon. The S.S. *India* from Mauritius to Colombo had moderate to strong south-west winds with showery weather on the 26th and 27th to the south-west of Colombo. The S.S. *Orono* from Mauritius to Bombay had squally weather with winds very variable in strength and direction between Lat. 13° S. and Lat. 5° N. on the 21st and seven following days.

Light variable winds obtained during the month over the whole of the Arabian Sea, except near the coasts, where moderate to strong winds prevailed.

The belt of strong local sea winds which usually prevail off the Sind and Kathiawar Coast did not extend more than 150 to 200 miles from the land off the west coast of India.

The mail steamer *Persia,* which arrived in Bombay on the 31st May, had light variable winds in her passage from Aden. Her log shows that pressure was practically normal over the sea area between Aden and Bombay; in this respect differing from the conditions in the latter part of May 1899, when there was a considerable excess of pressure which persisted steadily throughout the monsoon period.

33. *Summary of the preceding information.*—The most important facts relating to the south-east trades region are:

(1) The past five months have been much wetter than usual over the greater part of South and Central Africa. The meteorological conditions of that area resemble in some respects those of 1899, but differ entirely from those obtaining in 1896, 1897 and 1900.

(2) The available data indicate that the meteorological conditions in South and probably Central Africa have been very remarkable and abnormal, and that the rainfall during the past six months is the heaviest on record and probably for over 100 years.

(3) Although the rainfall has been almost unprecedented in amount, the northward march of the rainfall in East Africa has apparently been quite normal. The northward march in South Africa began a fortnight earlier than usual and was followed by much drier weather than usual in the Cape Colony. The northward march of the humid currents gave excessive rain in Central Africa in March, April and May (the normal period) and the information from Egypt indicates the northward extension to the Soudan slightly earlier than usual.

(4) The information from Zanzibar and the Seychelles suggests that the south-east trades in May were much stronger than usual in the north-westward part of the extension of these currents. The pressure conditions at these stations and Mauritius were normal at the end of May.

(5) The information obtained from ship's logs shows that at the end of May fine weather with light variable winds and a smooth sea obtained over the whole of the Arabian Sea to the north o fLat. 8°N., and that weather was showery and squally near the Equator to which the south-east trades had extended. There were indications shown by the observations recorded at observatories on the Ceylon and South Malabar Coasts that an advance of south-west monsoon winds or burst of the south-east trades across the Equator was in slow progress.

The information hence indicates that the south-east trades were probably stronger than usual at the end of the month, and that conditions were favourable for their early extension as south-west monsoon winds into the Arabian Sea.

The pressure conditions in the north and centre of the Arabian Sea as well as in North-Western India in the beginning of June are favourable to an early advance of monsoon winds and to a monsoon of at least normal strength. The only doubtful factor is the tendency of the humid currents to give excessive rain in East Africa, thus perhaps indicating an abnormal westerly determination; but so far as can be judged, this is not likely to affect the monsoon in India to any unfavourable extent.

FORECAST OF THE SOUTH-WEST MONSOON OF 1901 IN INDIA.

34. *The probable strength and general character of the south-west monsoon.*—In the preceding pages have been given for future reference the most important data utilized for the preparation of the following forecast :

The most important points for determination under this head are—

(1) The probable general strength and character of the monsoon currents, as rain-giving and distributing currents.

(2) The relative strength of the two currents, *viz.*, the Arabian Sea and the Bay currents.

The first point is, in the absence of much necessary information, the most difficult to estimate, and the conclusions arrived at below should, it may be again noted, be considered as probabilities based on very imperfect information.

35. The chief factors or indications that have to be taken into consideration for the determination of the probable general strength of the monsoon currents during the present year are the following :

(1) The phase of the sun spot periodicity.

(2) The strength of the south-east trades winds (as indicated by the information received from South Africa, Mauritius, Zanzibar and the Seychelles), and more especially, the partial similarity between the first five months of the present year and the corresponding period of the year 1899.

(3) The general experience of the succession of seasons in India, and hence of a weak monsoon in one year being followed by a strong monsoon during the next year.

(4) The general meteorological conditions of the Indian monsoon area during the past six months and more especially during the hot weather months of April and May.

(5) The character and period of the winter snowfall in the Western Himalayas and Persian area.

(6) The strength and character of the monsoon and distribution of the accompanying rainfall in previous years of similar conditions in India.

36. The following is a brief statement of these factors in the present year and the chief inferences derived from their consideration :

(1) The connection between sun spot periodicity and rainfall in India has been recently discussed in a paper read before the Royal Society. In that paper it was pointed out that the drought and famine of 1899 coincided with a remarkable variation in the sun indicating higher temperature than is usual before and at the minimum epoch of the sun spot period. Mr. Hutchins in his memorandum (page 36) suggests that these remarkable conditions have not yet passed away, and has hence inferred the possibility of another abnormal year and possible large deficiency of rainfall. Solar observations at Kodaikanal and Poona indicate, however, that the minimum epoch is past. Sun spots are again appearing on the sun's surface and the iron lines, the absence of which in the spectra of the sun spots was the chief

factor are re-appearing. I have also been informed that the present phase of the sun spot period is similar to that of the year 1878 and (to a less extent) that of 1889. These years were characterized by favourable and abundant rains. The indications for good rains based on this factor are hence favourable for at least normal monsoon rains.

(2) The information received from South Africa and the Indian Ocean indicates that the south-east trades are above their normal strength and have given unusually abundant rain during the past six months in the land areas. The rainfall in South Africa was unprecedentedly heavy in January and February, in this respect resembling the rainfall in the same area in the corresponding period of 1899. Zanzibar and probably Central Africa received very heavy rain in April and May of the present year as in 1899. There is hence a considerable resemblance between the two years. In 1899 the rains continued in South Africa through May, June, July and August, whereas in the present year they ceased earlier than usual in April and the area of the heavy general rain has advanced northwards through Central Africa at the normal rate as is shown by the fact that the South Soudan began to receive its monsoon rains about a fortnight earlier than usual. The abnormal features of 1899 which gave rise to the very weak monsoon of that year and the failure of the Bombay rains are hence absent from the conditions of the present year. The most probable inference is that the south-east trades are unusually strong and that their continuation, the monsoon currents, will be equally strong and will give normal to abundant rain. The only doubtful element is the conditions in Central Africa which may possibly be such as to continue during part of the monsoon period the abnormally strong indraught into East Africa which prevailed in April and May, to the detriment of India. The information from Cairo, brief as it is, is opposed to this supposition. Hence, so far as the whole of the available information goes, it is certain that the south-east trades are strong, and it is very probable that their continuation, the south-west monsoon currents, will be of at least normal strength and give at least normal rain on the average of the whole Indian area.

(3) An examination of the rainfall data of India for many years gives the following results:

(*a*) Years of very deficient rainfall are in about five cases out of six followed by years of normal rainfall or of slight excess.

(*b*) Years of deficient rainfall occasionally occur in pairs, the most notable examples during the past thirty years being 1876-77, 1895-96 and 1899-1900. A year of deficient rainfall is followed in about one out of four cases by a second year of deficient rainfall.

(*c*) Years in which the rainfall is very largely in defect are in about two cases out of five followed by years of much heavier rain than usual.

(*d*) The probability of two years of deficient rainfall being followed by a third year of very deficient rain is very small, no such case having occurred during the past 25 years.

The experience of the past 40 years hence indicates that the probability of the present year being one of diminished monsoon rainfall is very slight.

(4) and (5) The distribution of the winter snowfall and the temperature and pressure conditions from January to April were undoubtedly slightly unfavourable to an early or strong monsoon. Important changes, however, occurred in May establishing conditions generally favourable over the whole of India (except the North Punjab). The pressure conditions over the Arabian Sea and the eastern half of the Indian Ocean were at the end of May normal. The conditions in

India, the Arabian Sea and the Bay of Bengal are undoubtedly favourable for a normal to a strong monsoon over nearly the whole Indian land area.

(6) The following gives the years of more or less similar conditions :

1878, 1884, 1885, 1889, 1891, 1893, 1897 and 1900.

The years of closest resemblance are 1878, 1891, 1898 and 1900. The consideration of the rainfall in these years and its relation to the pre-monsoon conditions of winter snowfall, pressure and temperature indicates that it is very probable the monsoon rains on the average of the whole of India will be in excess, and that the excess will be between 2 and 4 inches, or between 5 and 10 per cent. of the normal amount.

37. The conclusions derived from the consideration of the whole of the facts are—

(1) Judging from the conditions in India and the known conditions in the Indian seas and ocean, it is, on the whole, very probable the monsoon currents of the present year will be, as rain distributing currents, of at least normal strength on the average of the whole season and probable that they will be stronger than usual. It should, however, be noted that the heavy rainfall of the past two months in Central or Equatorial Africa points to the possible existence of conditions in that area unfavourable to a strong monsoon in India. So far as can be judged from the available information the probability of this effect is very small.

(2) The average rainfall of the whole of India will probably be between 2 and 4 inches, or 5 and 10 per cent. in excess.

(3) It is probable there may be a slight delay in the establishment of the monsoon currents on the Bombay Coast. The delay will very probably be slight, and it is probable that the rains will set in fully on the Bombay Coast before the middle or end of the second week of June. The monsoon rains will probably begin about the normal date, in the third week of the month, on the Bengal Coast.

(4) The Bombay current is more likely to be above its normal strength than the Bay current.

38. **The probable distribution of rainfall in India.**—The chief features or local conditions in India which have to be taken into account in estimating the probable distribution of rainfall during the approaching monsoon due to normal or slightly stronger monsoon currents than usual are :

(1) The distribution of the winter snowfall in the mountain areas to the north and north-west of India.

(2) The abnormal features of the pressure, temperature and humidity conditions of the past five months and more especially the temperature and pressure conditions in May. It is assumed that no large changes of these features will occur during the period of delay of the monsoon in June.

39. The following inferences respecting the distribution of the south-west monsoon rains of 1901 in India are deduced from the comparison of the antecedent conditions of the present year with those of previous years and are based chiefly on the facts and data stated above :

(1) Conditions are favourable generally in Burma—more especially in Lower Burma. The rainfall of the period will probably be in excess in Lower and Central Burma and about normal or in slight defect in Upper Burma.

(2) Conditions are practically normal in Assam and Bengal and are very slightly more favourable in East and North Bengal and Assam than in West Bengal. These areas will probably receive about normal rain. The rainfall is more likely to be excess in East and North

Bengal than in South-West Bengal. The rainfall in Assam will probably be normal or in slight excess.

(3) Conditions are almost as favourable in Bihar and Chota Nagpur as in the North-Western Provinces. It is probable that the rainfall will be normal in Chota Nagpur and normal or in slight excess in Bihar.

(4) Conditions are favourable in the North-Western Provinces—more especiallv in the eastern districts where there is a local deficiency of pressure of some importance. It is very probable that the rainfall will be in slight to moderate excess, except in the south-western and western districts, where it may be normal.

(5) Conditions are slightly unfavourable in the Punjab, due chiefly to the excess of pressure in the northern districts—a residual effect of the late heavy snowfall in Kashmir and Chitral. On the supposition of a monsoon of normal strength, it is probable that the monsoon rainfall of the present year will probabiy be about normal in the eastern districts and below the normal to a moderate extent in the western and northern districts. The character of the rainfall in this area, however, depends chiefly on the general strength of the monsoon and not on the local conditions, and these conclusions should be suitably modified if the monsoon turns out to be stronger than is assumed in drawing up the forecast.

(6) Conditions are, on the whole, favourable in Rajputana—more especially in the eastern and central districts. The monsoon rainfall will hence very probably be normal or in slight excess. The rainfall in Rajputana, as in the Punjab, depends chiefly on the general strength of the monsoon, and hence if the Bombay monsoon current be strong, the rainfall may be favourable and in excess over the whole area.

(7) Conditions are almost as favourable in Central India as in the North-Western Provinces, and it is probable that area will receive about normal rainfall. The rainfall is more likely to be in excess in the eastern than the western states.

(8) Conditions are, on the whole, favourable in the Central Provinces and Hyderabad. It is hence probable that these areas will receive at least normal rainfall. The conditions are slightly more favourable in the eastern than the western districts of the Central Provinces, and it is hence probable that the eastern districts may receive rainfall in slight to moderate excess of the normal. They are very slightly less favourable in Hayderabad than the Central Provinces, and the rainfall in that area will probably be normal or in slight excess.

(9) Conditions are practically normal in Berar and Khandesh, and the rainfall in these areas will probably be about normal. They are more favourable in the West Deccan and that area will very probably receive its normal fall.

(10) The conditions in the west coast districts are such as are, in years of normal monsoon conditions, usually associated with normal rainfall. It is hence probable that the rainfall of the present year's south-west monsoon will be in moderate to considerable excess in those districts, if, as is not probable, the rains are not greatly delayed. It is probable it will be normal in Malabar.

(11) The variations of the rainfall in the North Madras Coast districts are in at least five years out of six similar to those of Orissa and the Central Provinces. Conditions appear to be, on the whole, favourable, and it is probable those districts will receive about normal rain.

(12) A comparison of the conditions in the Madras Deccan, Mysore and the Carnatic with those of similar years indicates that the rainfall

during the period—June to September—will probably be in slight excess in Mysore and the Deccan—more especially in Mysore and normal or in slight defect in the Carnatic. It is difficult to forecast for this part of India, as rain in the southern half of the Peninsula during the monsoon proper occurs chiefly during the intervals of breaks in the rains in Northern India, and is hence essentially of irregular occurrence.

40. It should be carefully noted that the preceding probabilities are obtained on the assumption that the currents will be about normal or slightly stronger than usual. They will require to be suitably modified if the monsoon currents should be much weaker than is anticipated from the data. It should also be noted that the chances for an inference stated to be very probable are at least 5 to 1 and for an inference stated to be probable at least 5 to 2.

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SIMLA ;
The 6th of June 1901.

J. B. FULLER,

Offg. Secretary to the Government of India.

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